Appendix I (June 4 draft)

Staff Report: Analysis of Water Quality Issues in EPA's February 2011 ANPR

All Bay Delta Estuary waters are impaired by one or more contaminant. Aquatic uses are further adversely affected by a lack of adequate habitat. Discussed below are those water quality stressors which EPA believes are most significant, individually and/or cumulatively, for aquatic species health in the Estuary, including:

- Selenium
- Ammonia
- Pesticides
- Contaminants of Emerging Concern
- Declining Estuarine Habitat
- Fragmented Fish Migration Corridors
- Loss of Wetlands, Floodplains and Riparian Corridors

These seven issues were discussed in detail in EPA's February 2011 Advance Notice of Proposed Rulemaking (ANPR). In this appendix, for each issue, we include:

- a short statement of the problem and the current regulatory response (a more detailed discussion is in the ANPR, which is included for reference as Appendix III);
- highlights of the input received from the public in response to the ANPR (Appendix II is a full synthesis of public comment); and
- EPA's assessment of the adequacy of that regulatory response and staff recommendations for additional actions.

EPA has attempted to be as specific as possible about actions needed to improve the Estuary's water quality so that it will better support aquatic species. At the same time, EPA recognizes that the next twenty years will be a period of significant change in the Bay Delta Estuary. Accordingly, EPA intends to evaluate the progress on these recommended actions in light of the evolving understanding of aquatic resource protection in the Bay Delta Estuary, so that Agency activities are always targeted to the most critical needs.

The recommended actions include those EPA can take directly using the Agency's existing statutory authorities. In certain cases, EPA is not able to commit to implement the staff recommendation and this is stated. Also included are recommend actions the State of California might take under the delegated federal Clean Water Act (CWA) program. Collectively, these actions will contribute to the restoration of the Bay Delta Estuary. Even if they are all successfully implemented, however, they are not sufficient to resolve the multifaceted problems that have stressed the ecosystem to the point of collapse. These actions must be accompanied by progress on many other related fronts.

A. Selenium

1. The Problem

Selenium is a naturally occurring element that, when mobilized in the environment and transformed to organic, bioavailable forms, is highly bioaccumulative. Selenium in the diet, even in very small amounts, can produce birth defects and limit reproductive success in sensitive fish and wildlife. Selenium may also biomagnify and affect predators at the top of the foodweb. The main controllable sources of selenium in the Bay Delta Estuary are agricultural drainage (generated by irrigation of seleniferous soils in the western side of the San Joaquin Basin) and discharges from North Bay refineries (which process selenium-rich crude oil from the southern San Joaquin Basin).

2. CWA Program Response

Selenium sources in both the San Joaquin Basin and in the North Bay are regulated under permits. In the San Joaquin Basin, three related Total Maximum Daily Loads (TMDLs) are being implemented in the Grasslands Bypass Project (GBP).[1] Operating under Waste Discharge Requirements issued by the Central Valley Regional Water Quality Control Board (Central Valley RWQCB) pursuant to State water quality law, the GBP is the key effort to date to control selenium discharges to the San Joaquin River. The drainage and water districts participating in the GBP have reduced selenium loads to the point that dischargers are now in compliance with existing selenium standards in the San Joaquin River between the Merced River confluence downstream to the South Delta confluence.[2] However, water quality standards are not being met in the San Joaquin River reach upstream of the Merced confluence to Mud Slough and, according to U.S. Fish and Wildlife Service (USFWS), juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in the entire San Joaquin River may still be at risk from the adverse effects of selenium at the levels currently permitted by the California Toxics Rule and Central Valley Region Basin Plan.[3]

North Bay refineries are regulated through federal CWA point source National Pollution Discharge Emission System (NPDES) permits. The permittees are conducting studies on the concentrations and speciation ambient levels of selenium as well as selenium in their effluent. Further reductions in selenium discharges to waterways may be needed to adequately protect selenium-sensitive species such as the salmon and the North American green sturgeon (*Acipenser medirostris*, a downstream resident of the Bay Delta Estuary). EPA anticipates that the San Francisco Regional Water Quality Control Board (San Francisco RWQCB) will consider this issue as it completes the North San Francisco Bay Total Maximum Daily Load (TMDL).

3. Public comments

Public comments generally acknowledged the importance of improving regulation of selenium [4]by filling data and scientific gaps that currently limit our understanding of (a) the forms of selenium entering the system, especially particulates that are more bioavailable; and (b) loading and transport in the Bay Delta Estuary under varying hydrologies (particularly high flow periods which are likelier to transport particulates). They recognized the value of the United States Geological Survey (USGS) Presser-Luoma biodynamic model (discussed below), provided the data used are up-to-date. Thus, there was support for more extensive monitoring. A number of parties suggested, or were open to considering, retiring of drainage impaired lands in the western San Joaquin Valley as one strategy for controlling selenium inputs to the aquatic environment.

4. CWA Program Assessment and Recommendations

Our current understanding of ecosystem foodweb processes that concentrate selenium suggests that existing selenium water quality standards do not adequately protect aquatic species and wildlife in the Bay Delta. Existing standards are based on a water column value that does not reliably reflect the actual dietary exposure of species, as measured in tissue concentrations. Therefore, EPA has concluded that several additional actions are needed to better protect aquatic species in the Bay Delta Estuary:

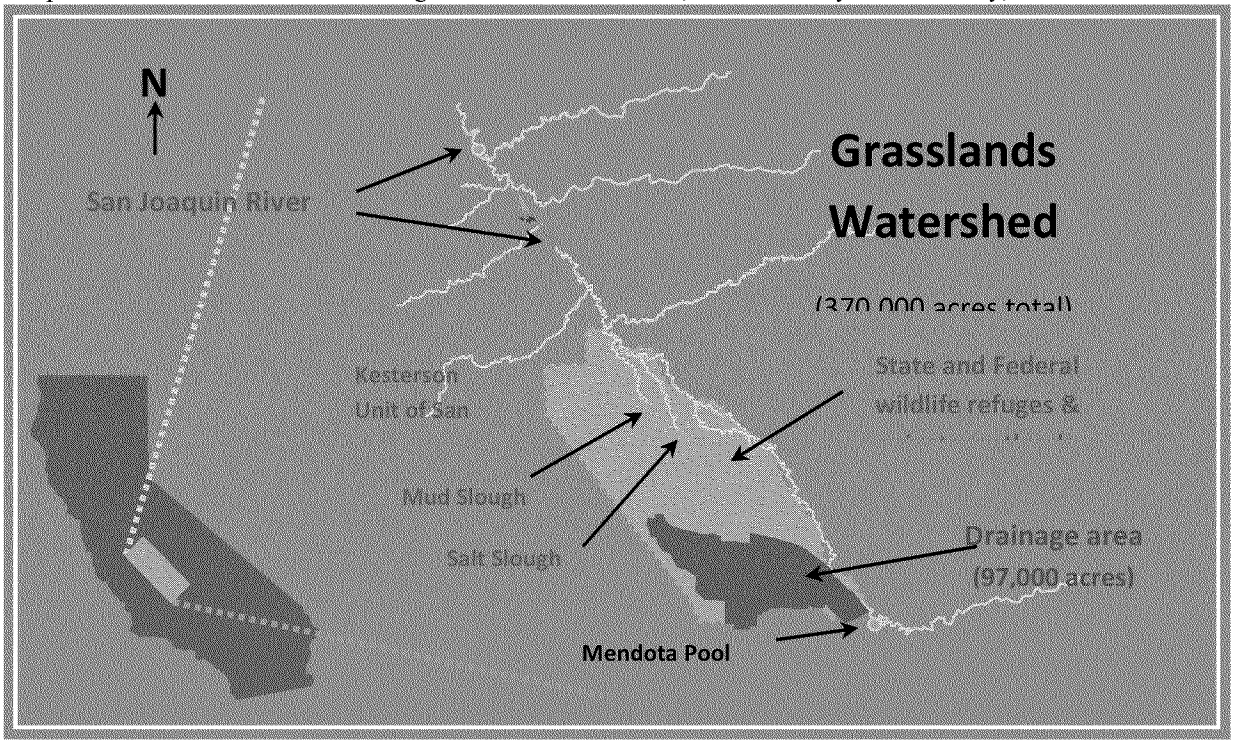
a. By December 2012, EPA Region 9 will complete the technical work to support new site-specific numeric selenium criteria for protection of aquatic species in the Bay Delta Estuary (aquatic life) and terrestrial species dependent upon the aquatic habitats of the Estuary. EPA is using an ecosystem-based model created by the USGS [5] that reflects the food web in the Bay Delta Estuary, the diet of sensitive species, and their use of habitats and hydrological conditions. Formal public proposal of new criteria will follow scientific and agency reviews. The new criteria will likely decrease allowable concentrations of selenium in surface waters of the Bay Delta and would set maximum selenium concentrations in the tissue of fish and wildlife.[6]

This is the first phase of revising selenium criteria statewide. For areas in California outside the Bay Delta Estuary, EPA Region 9 will support subsequent regulatory criteria development using the ecosystem-based methodology developed by the USGS, tailored to address threatened or endangered species in other watersheds.

b. At the national level, EPA is developing national "guidance" criteria for selenium to protect aquatic life in freshwater, based on methodology consistent with the USGS model. The national numeric criteria will be tailored to different hydrological conditions (flowing and standing waters), but it will not account for the effects of selenium on threatened or endangered species. States and tribes can use these "guidance criteria" to regulate selenium, and/or EPA can use them to promulgate water quality standards on behalf of states and tribes.

c. EPA will support development and implementation of a TMDL for selenium in the North San Francisco Bay, Suisun Marsh and the West Delta (generally referred to as the North San Francisco Bay TMDL) and recommends that the TMDL use the site-specific criteria work under development by EPA , as described in "a" above. In January 2011, the San Francisco RWQCB issued a report integrating the technical analyses completed to date. The January report acknowledges that there are significant data and assessment gaps, such as information on sources and distribution of particulate selenium, which is the form more biologically available.[7] The State's implementation of this TMDL will focus on the major point sources (refineries) and the significant non-point loads entering from the Delta and its watershed. The discharge permits for the five refineries are due to be renewed within five years, at which time waste load allocations for selenium would be reviewed. Load allocations will address upstream sources coming into the Bay from the Delta.

The Grasslands Watershed encompasses 370,000 acres of intermingled wetlands and farms on the west side of California's San Joaquin Valley. Soils in this region are rich with selenium, a naturally occurring trace element that becomes toxic at high concentrations. With irrigation, selenium builds up in both surface water and shallow groundwater. In the Grasslands, as well as the larger Westlands Water District to the south, maintaining agricultural production often requires removing shallow ground water. However, selenium in this drainage water puts sensitive species at risk. This was dramatized when drainage water conveyed via the San Luis Drain from Westlands to a wetland area, Kesterson, caused deformities in migratory birds. The San Luis Drain was closed and Kesterson remediated. Unlike Westlands, which is now prohibited from exporting drainage to the San Joaquin watershed and Delta, runoff and agricultural drainage from the Grasslands watershed naturally enter the San Joaquin River. To avoid contaminating the Grassland wetlands, River and Bay Delta Estuary, selenium control is a priority.



In 1996, stakeholders established the Grasslands Bypass Project (GBP), which uses the San Luis Drain to divert selenium-laden agricultural drainage water away from sensitive wetlands while implementing a selenium reduction program to meet water quality standards within a specified period of time. Discharge into Mud Slough from the Drain is subject to Waste Discharge Requirements issued by the Central Valley RWQCB that are linked to three TMDLs for selenium. Unique features of the GBP include:

- Organization of a regional drainage entity to coordinate selenium reduction activities;
- Enforceable reduction targets for selenium loads and incentive fees that are managed through an account used for selenium controls;
- A performance-based program that provides the irrigation districts and drainage district flexibility to determine how to best meet overall selenium reduction targets in a cost-effective manner; and
- A monitoring, assessment and reporting program supported by an interagency technical workgroup.

Under the GBP, participating irrigation districts have reduced their discharges of selenium by up to 90% through on-site measures such as increasing irrigation efficiency and reusing irrigation water. Full compliance with water quality standards has taken longer than originally planned, and reaching the GBP goal of zero discharges of selenium by 2019 may require unproven treatment technologies or substantial reduction in irrigation. Even if water quality standards are met within a decade, as envisioned under the GBP, protecting water quality and sensitive species will require long-term management of selenium in the San Joaquin River basin. This introduces several questions that cut across science, policy, and management:

- ✓ The focus on controlling discharges of selenium to surface waters can encourage practices that "store" selenium elsewhere, e.g., groundwater. Will this accumulated selenium ultimately enter pathways that adversely affect sensitive species in the short- or long-term?
- ✓ How can we promote technically and economically feasible means of reducing volumes of contaminated drainage water?
- ✓ What needs to be done now by agencies and the agricultural community to establish the institutional framework necessary for this perpetual challenge?

d. EPA will continue to participate in the Grasslands Bypass Project (GBP) through the

B. Ammonia

1. The Problem

Aquatic life toxicity caused by total ammonia nitrogen is one of the suspected contributors to the pelagic organism decline in the Bay Delta Estuary.[8] Monitoring data, laboratory testing, and multi-year field observations indicate that concentrations of total ammonia nitrogen in Bay Delta waterways may be toxic to desirable algae species and invertebrates which are significant food sources for pelagic fish.[9] Depressed algal populations and primary productivity is also caused by light limitation and clam grazing in the Bay Delta Estuary. Total ammonia nitrogen levels in Bay Delta waterways may also preferentially support an aquatic ecosystem community composed of toxic blue green algae and jelly fish.[10] Although there is evidence that ambient levels of total ammonia nitrogen may negatively impact aquatic habitat and populations (designated uses), monitoring data show that ammonia concentrations are below the EPA recommended 1999 Ammonia Aquatic Life Criteria. None of the waterways in the Bay Delta Estuary are on the 2010 California List of Impaired Waterbodies due to elevated levels of ammonia.

There is a broader concern about nutrient over-enrichment in the Bay Delta Estuary. Nutrients include discharges of total ammonia nitrogen and other nutrient chemical species such as phosphorus and other forms of nitrogen. San Francisco Bay has high nutrient (nitrogen and phosphorus) loads and high nutrient concentrations.[11] Nutrient loads and concentrations in San Francisco Bay are comparable to those in Chesapeake Bay which exhibits symptoms of nutrient over-enrichment such as a high abundance of algae, primary productivity, and oxygen depletion. Unlike Chesapeake Bay, the Bay Delta Estuary has low algal abundance and low primary productivity, but it isn't characterized by the chronic problems of coastal eutrophication[12] like Chesapeake Bay. Conditions in the Bay Delta Estuary that limit algal abundance include extensive clam grazing, strong tidal mixing, short water residence times, and light limitation from high turbidity. Algal abundance and dissolved oxygen trends from the last ten years indicate that the resilience of the Bay Delta Estuary to the effects of nutrient over enrichment is weakening. Algal abundance is increasing and dissolved oxygen is decreasing in parts of the Bay causing water resource managers to consider methods for controlling nutrients.[13]

2. CWA Program Response

The Central Valley RWQCB addressed the largest known point-source of ammonia to the Bay Delta Estuary, the Sacramento Wastewater Treatment Plant (SRWTP), by updating the SRWTP NPDES permit in 2010. SRWTP discharges approximately 14 tons of ammonia per day to the Sacramento River in the Delta portion of the Estuary.[14] Significant changes in the new permit include enhanced treatment ammonia removal (nitrification), and ammonia effluent limitations.[15] The new permit provides a 10 year compliance schedule that details performance-based interim effluent limits for ammonia until the facility is fully upgraded to treat for ammonia. SRWTP must meet the final effluent limits at the end of the compliance schedule.[16] The ammonia limits identified in the new NPDES permit were supported by EPA, USFWS, California Department of Fish and Game (DFG) and the California Department of Water Resources (DWR) and other water agencies.

In January 2011, the plant operator appealed the permit to the State Water Resources Control Board (SWRCB).[17] In May2012, the SWRCB upheld the denial of a mixing zone for ammonia and remanding to the Central Valley RWQCB a recalculation of the final ammonia effluent limitation based on pH and temperature adjustments.[18] EPA will continue to support the Central Valley RWQCB and the SWRCB as they resolve the permit appeal.

In addition, the SWRCB and San Francisco Bay RWQCB are developing a Nutrient Numeric Endpoint (NNE) assessment framework to address nutrient over-enrichment in the western portion of the Bay Delta Estuary (excluding the upper estuary and Delta). The NNE will translate narrative water quality objectives into numeric endpoints that are protective of water quality and ecosystem responses. [19]

3. Public Comments

Public comments from multiple stakeholder groups recommend evaluating the need for site-specific ammonia water quality standards based on: (1) observed total ammonia nitrogen toxicity to Delta copepods; (2) observed ammonia inhibition of diatoms in Suisun Bay; (3) documented toxicity levels in the Bay Delta Estuary that are substantially lower than current and proposed EPA Ammonia Aquatic Life Criteria; and (4) global evaluations of the effects of changing nutrient dynamics on aquatic ecosystems. Commenters support the use of the SWRCB Numeric Nutrient Endpoints (NNE) framework as one method of establishing site specific total ammonia nitrogen standards. Two stakeholder groups commented that there is not a consensus in the scientific community about the role that total ammonia nitrogen, or other nutrients, plays in driving ecological problems, including the pelagic organism decline. In addition, these comments identify other factors such as light availability and clam grazing as the primary drivers of low primary productivity. Commenters also identified additional information for EPA to evaluate, described the complexity of nutrient interactions with aquatic species, and identified a need to quantify total ammonia nitrogen sources and load contributions to the Bay Delta Estuary.

4. CWA Program Assessment and Recommendations

There is evidence that total ammonia nitrogen concentrations in Bay Delta Estuary waters are negatively impacting designated uses. The Water Boards are using CWA and state programs to remediate this problem. The SWRCB and Central Valley RWQCB recently addressed the largest source of total ammonia nitrogen to the Bay Delta Estuary by requiring ammonia removal and denitrification in the recent update to the CWA NPDES permit for the SRWTP. Similarly, the Water Boards are developing the NNE framework that will eventually control rising nutrient loadings to the western part of the Estuary. In addition, the State's Delta Stewardship Council is recommending that the SWRCB, San Francisco Bay RWQCB and Central Valley RWQCB develop and adopt numeric or narrative objectives for nutrients in the Delta and Delta watershed by January 30, 2014.[20]

EPA has concluded that several additional actions are needed to better protect aquatic species in the Bay Delta Estuary:

a. EPA supports efforts of the Central Valley RWQCB and the Sacramento County

Regional Sanitation District to identify actions that minimize ammonia discharges pending the upgrade of the SRWTP. Under the SRWTP NPDES permit compliance schedule, it could be ten years before plant upgrades are constructed and actively removing ammonia from effluent. Developing and implementing a strategy for reducing ammonia discharges to protect beneficial uses during this interim period is a high priority. SRCSD submitted a plan outlining potential interim ammonia reduction actions which is under review by the Central Valley RWQCB.

b. EPA will finalize new national Ammonia Aquatic Life Criteria. EPA proposed updated Ammonia Aquatic Life Criteria in 2009 which are more stringent than the existing criteria promulgated in 1999.[21] Aquatic Life Criteria are established and updated by EPA to protect aquatic life from harmful effects of contaminants in surface waters nationwide. The proposed Ammonia Aquatic Life Criteria are a function of pH, temperature, and presence of sensitive organisms (unionid mussels). The proposed acute criteria are 2.9 mg N/L with mussels present (pH = 8.0, Temperature = 25 deg C) and 5.0 mg N/L without mussels present (pH = 8.0, Temperature = 25 deg C).[22] The Regional Water Boards may use the updated Ammonia Aquatic Life Criteria to calculate effluent limitations when NPDES permits are renewed, or prior to permit expiration through re-opener clauses if monitoring data indicate ammonia effluent concentrations exceed the new criteria.

c. EPA recommends that the State and Regional Water Boards either expand the San Francisco Bay NNE effort to include the Delta or establish a program for addressing and controlling nutrients in the Delta. The San Francisco Bay NNE framework is focused on the western part of the estuary, excluding the Delta. Expanding this effort to include the Delta is an important step toward protecting beneficial uses of the entire Bay Delta watershed because the ecological resilience of San Francisco Bay is inextricably linked with water quality and nutrient loading in the Delta and its tributaries.

C. Pesticides in Agricultural and Urban Polluted Runoff

1. The Problem

Aquatic toxicity caused by land-applied pesticides is one of the most common causes of water quality impairment in California and in the Bay Delta Estuary.[23] Toxicity to algae, invertebrates, and fish caused by pesticides has been observed and documented in the Bay Delta Estuary and its tributaries for twenty-five years.[24] All of the water bodies in the Bay Delta Estuary are on the SWRCB 2010 List of Impaired Waterbodies due to aquatic resource designated use impairments caused by diazinon, chlorpyrifos, pyrethroids, and/or legacy pesticides.

Pesticides are transported to the Bay Delta Estuary and its tributaries through urban and agricultural runoff, wastewater treatment plant discharges, and atmospheric deposition. Urban runoff includes wet- and dry-weather runoff[25] that flows over urban landscapes[26] and is discharged either directly into streams and rivers (nonpoint sources) or moves into storm sewer pipes (point sources) before being discharged into rivers and streams. Many contaminants, including pesticides, are found in urban runoff. Agricultural runoff includes precipitation and irrigation water that flows over agricultural fields directly into rivers and streams or into irrigation return flow systems (channels or pipes) before joining rivers and streams. Agricultural runoff is considered nonpoint source water pollution. Pesticides and fertilizers (nutrients) are common contaminants in agricultural runoff. Pesticide sales data combined with California Department of Pesticide Regulation (DPR) reporting indicate that urban pesticide use could be at least 50% of total statewide use.[27]

Increased attention has been focused on pesticides in urban runoff in the Bay Delta Estuary since the late 20th century due to a high occurrence of observed sediment and aquatic toxicity caused by organophosphate and pyrethroid pesticides. During this period of time, more than fifty thousand acres of new urban development spread rapidly across the Sacramento Region,[28] including western Placer, Sacramento, San Joaquin, Solano, Sutter, and Yolo counties. Toxicity events caused by organophosphate and pyrethroid pesticides have occurred in multiple urban creeks that drain into the Bay Delta Estuary.[29] In the last six years, urban storm sewer outfalls draining new development in the suburbs of western Placer County and the City of Sacramento were identified sources of pyrethroid-caused aquatic toxicity.[30]

Some pesticide water pollution problems are caused by pesticides currently registered by EPA under the Federal Insecticide Rodenticide and Fungicide Act (FIFRA). Individuals or companies seeking to register pesticides with EPA Office of Pesticide Programs (OPP) must submit data that allows EPA to evaluate the potential impacts of the new chemical on ecosystems.[31] However, EPA must make ecosystem assessments using data that may not include data for the most sensitive species. In addition, FIFRA allows registration of pesticides that may pose some risk to aquatic life if the economic benefit of the proposed pesticide use is very high. This can lead to situations, such as in the Bay Delta watershed, where legally registered and applied pesticides cause aquatic life toxicity and water quality impairments.[32]

2. Water Quality Program Response

There is much ongoing work under the CWA, FIFRA and California water and pesticide laws aimed at minimizing pesticide water pollution:

EPA activities

CWA-FIFRA Harmonization. EPA recognizes the value in "harmonizing" its CWA and FIFRA programs. For example, EPA is developing a "Common Effects Methodology" to establish a common approach under FIFRA and CWA for estimating effects of pesticides on aquatic life.[33] As part of this effort, EPA Region 9 is participating in workgroups that address criteria method development, fate and transport modeling, water quality monitoring, regulatory review of pesticide-related permits, and pesticide registration and re-registration.

National Storm Water Rule. EPA is strengthening the storm water program through developing new regulations which may expand protection of the municipal separate storm water sewer systems (MS4) program.[34] to address discharges from new development and redevelopment that may be contributing to water quality impairments.[35] This rulemaking may include the development of performance standards designed to reduce storm water quantity, velocity, and contaminant concentrations using project design features, such as low impact development (LID) landscaping designs and best management practices that improve storm management on-site and reduce contaminant levels in urban runoff before water leaves the site.

Technical Support. EPA worked with the California Department of Water Resources (DWR), the University of California-Davis and DPR to develop a model that assists in identifying the role of 40 pesticides in the Pelagic Organism Decline by identifying spatial hotspots for pesticide mass loadings to sensitive species of concern. This project, the "Spatial and Temporal Quantification of Pesticide Loadings to the Sacramento River, San Joaquin River and Bay Delta to guide Risk Assessment for Sensitive Species" was completed in 2011[36]. Its results identify and rank areas in the Bay Delta Estuary of highest potential risk for pesticide loadings and the pesticide source areas contributing to those risks. This information can inform pesticide TMDLs, nonpoint source control actions, best management practices, and monitoring locations.

State of California

California is a national leader in monitoring and investigating pesticide effects on aquatic species and taking actions to reduce pesticide-caused water quality impairments and aquatic toxicity through pollution prevention programs. State agencies are using federal CWA tools and state water and pesticide laws to identify numeric water quality criteria, support monitoring, reporting, and assessment programs, control pesticides at the discharge site, and remove pesticides from runoff before entering the aquatic ecosystem.

The California Department of Pesticide Regulation (DPR) administers pesticide pollution prevention programs that control and track pesticide use including: pesticide registration, continuous evaluation and re-evaluation of pesticides in the environment, licensing and certification for agricultural and urban applicators, environmental monitoring, pesticide use reporting and surface water quality protection. DPR is also enforcing the federal cancelled registration of urban diazinon and chlorpyrifos use. The DPR surface water quality program identifies pesticide residues in surface waters and the sources of contamination, determines the pathways and mechanisms that move pesticides off the application surface into surface water, develops and promotes site-specific mitigation actions and adopts restrictions to protect surface water from contamination.[37]

In 2011, DPR issued two sets of draft surface water protection regulations. One set of regulations address pesticide drift and runoff by prohibiting pesticide application within 100 feet from a sensitive aquatic resource and to saturated soils within 48-hours of a predicted storm event. They also require retention of irrigation runoff up to four weeks after application and restrict pesticide application to spot and crack-and-crevice treatment on impervious surfaces.[38]

DPR's second set of regulations, "Prevention of Surface Water Contamination by Pesticides" will reduce pyrethroid pesticide use in outdoor non-agricultural settings. The proposed regulations narrow application methods for 17 pyrethroids to spot, pin-stream, and band spray treatments, depending on the type of impervious surface and prohibit applications during rainfall, to standing water, and under certain other conditions.[39] Research completed at University of California, Davis, suggests that application methods required by the DPR proposed surface water quality regulations could yield an 80% reduction in exposure of aquatic life to toxic levels of pyrethroids.[40]

The State Water Resources Control Board and Regional Water Quality Control Boards are addressing pesticide-caused aquatic resource impairments through their Nonpoint Source Program, Irrigated Lands Regulatory Program (ILRP), stormwater permits, TMDLs, and new numeric water quality criteria.

The Nonpoint Source Program (NPS)'s "Plan for California's Nonpoint Source Pollution Control Program" (Program Plan) outlines a 15-year strategy for preventing and controlling nonpoint source pollution so that the waters of California support a diversity of designated uses. The Program Plan is focused on performance-based implementation of nonpoint source water pollution control activities derived from TMDLs and watershed plans. California's NPS Program funds are available to support implementation of pesticide TMDLs. The Water Boards have provided approximately $19 million of state and federal funding for 32 NPS projects focused on implementing pesticide "best management practices" (BMPs) in the watersheds immediately upstream of the Bay Delta Estuary since 1990.[41]

The Irrigated Lands Regulatory Program (ILRP) is focused on minimizing nonpoint source pollution from agricultural runoff. The Regional Water Boards implement the ILRP by issuing waste discharge requirements (WDRs) and conditional waivers of waste discharge requirements[42] that require water quality monitoring. If monitoring data show that water quality criteria are exceeded, BMPs are used to reduce loadings and additional monitoring is required until pesticide concentrations fall below water quality criteria. The ILRP is an important tool for restoring water quality that has already provided environmental benefits and water quality improvements.

TMDL Implementation. The Water Boards adopted and are currently implementing five pesticide TMDLs in the Bay Delta Estuary focused primarily on organophosphate pesticides, including: 1) Diazinon and Pesticide-Related Toxicity in Urban Creeks in the San Francisco Bay Region, 2) Sacramento-San Joaquin Delta Diazinon and Chlorpyrifos, 3) San Joaquin River Diazinon and Chlorpyrifos, 4) Sacramento and Feather Rivers Diazinon and Chlorpyrifos TMDL and 5) Sacramento County Urban Creeks Diazinon and Chlorpyrifos along with their respective Basin Plan Amendments.

TMDL and ILRP implementation in combination with other efforts[43] are reducing pesticide concentrations in receiving waters. For example, diazinon loadings have been successfully reduced below the diazinon water quality criteria in the Sacramento and Feather Rivers, both tributaries to the Delta.[44] Diazinon was subsequently removed as a source of impairment to aquatic resources on 79-river miles of the Sacramento and Feather Rivers in the 2010 CWA Section 303(d) List of Impaired Water Bodies.

Pesticide TMDL and water quality criteria development. The Central Valley RWQCB is developing water quality criteria and related TMDLs for current use pesticides for all waterways in the Central Valley that support aquatic life (including all Delta waters but excluding Suisun Bay and waters further westward in San Francisco RWQCB jurisdiction.) Phase I of this effort includes organophosphate pesticides (diazinon and chlorpyrifos). Phase II will address pyrethroid pesticides and potentially other pesticides of concern. Significant progress has already been made including:

- Identification of streams that should fully support aquatic life in the absence of elevated contaminant levels;[45]
- Risk ranking of pesticides;[46]
- Draft water quality criteria for seven of the high risk pesticides;[47]
- Identification and evaluation of agricultural BMPs;[48]and
- UC Davis water quality criteria methods.

A draft staff report for Phase I is anticipated in mid 2012, with Central Valley RWQCB adoption in late 2012. Phase II is anticipated to be completed approximately two years after Phase I.[49]

NPDES MS4 Permits. On May 18,2012, the SWRCB issued a draft statewide general stormwater permit for small MS4s[50] (or "Phase II") which covers municipalities with a population less than 100,000 and includes non-traditional MS4s such as military bases, prisons, and university campuses. The draft permit requires that the permittee evaluate their use of pesticides and reduce pesticide discharges by practices such as non-chemical landscape management, recording types and amounts of pesticides used in the service area, and preventing application of pesticides within two days of predicted rainfall. These pesticide provisions apply to the permittee only (e.g., city, county, campus) and do not apply to pesticide applications from individual landowners within the service area (e.g., home & business owners). The draft permit also contains a measurable LID provision, for some permittees, that requires storm water management systems in new developments to capture, infiltrate, or evapotranspire runoff from the 85th percentile storm (~1 inch of rain in 24 hours in Sacramento) after construction is complete.[51]

There are currently seven Phase I MS4 Permits regulating storm water discharges to the Bay

Delta Estuary (see Table 1). The San Francisco Bay and Central Valley RWQCBs recently updated the San Francisco Bay Region Municipal[52] and the East Contra Costa County MS4 permits to include consistent, measurable, and enforceable post-construction requirements intended to maximize the use of LID[53]. EPA supports the approach in these two permits along with seven others that contain measurable LID provisions.[54] The San Francisco Bay and East Contra Costa County MS4 permit updates also directly address pesticides and toxicity[55], and implement provisions of adopted TMDLs. These permits contain requirements similar to those in the Draft Phase II permit (e.g., implementing integrated pest management, recording types and amounts of pesticides used in the service area, train municipal employees, use certified commercial applicators, outreach and education). TMDLs for organophosphate pesticides are also being implemented through these permits by identifying control measures intended to reduce contaminant loads from storm water. Control measures are intended to make progress toward achieving the load allocations identified in the TMDLs.

3. Public Comments

Public comments emphasized source control through FIFRA, including eliminating methods of pesticide use and products that are likely to cause water quality problems using EPA's FIFRA registration process. Commenters suggest that EPA's effort to integrate CWA and FIFRA in the developing Common Effects Methodology is an important action toward eliminating a regulatory gap that can lead to elevated levels of pesticides in waterbodies. Comments reflect substantial concern about pyrethroid pesticides and support for EPA to address pyrethroids using the FIFRA registration process and CWA tools such as development of water quality criteria. However, some commenters question the ability of water quality criteria to address the interactive effects of pesticides with other contaminants and/or physical stressors on aquatic life.

Table 1: Phase I MS4 Storm Water NPDES Permits in the Bay Delta Estuary

Geographic Area of Permit	Permittees	Permit Number (Order, NPDES)	Date Adopted	Date Expires
City of Fresno	Fresno County, Cities of Fresno & Clovis, Fresno Metropolitan Flood Control District, California State University of Fresno	R5-01-048 CA0083500	3/16/2001	3/16/2006
City of Stockton		R5-2007-0173		

	City of Stockton and San Joaquin County	CA5083470		
City of Modesto	City of Modesto	R5-2008-0092 CA5083526	4/2/2007	6/12/2013
Sacramento Metropolitan	Sacramento County, Cities of Citrus Heights, Elk Grove, Folsom, Galt, Rancho Cordova, & Sacramento	R5-2008-0142 CA5082597	9/11/2008	9/11/2013
SF Bay Region	Alameda Countywide Clean Water Program,[a] Contra Costa Clean Water Program,[b] Santa Clara Valley Urban Runoff Pollution Prevention Program[c] San Mateo Countywide Water Pollution Prevention Program[d] Fairfield-Suisun Urban Runoff Management Program.[e]	R2-2009-0074 CA51612008	10/14/2009	11/30/2014
East Contra Costa County (CCC)	Cities of Antioch, Brentwood, Oakley, CCC, CCC Flood Control and Water Conservation District	R5-2010-0102 CASO83313	9/23/2010	9/1/2015
Port of Stockton	Stockton Port District	R5-2011-0005 CA5083526	2/3/2011	2/1/2016

a. Includes the cities of Alameda, Albany, Berkeley, Dublin, Emeryville, Fremont, Hayward, Livermore, Newark, Oakland, Piedmont, Pleasanton, San Leandro, and Union City, Alameda County, the Alameda County Flood Control and Water Conservation District, and Zone 7 of the Alameda County Flood Control and Water Conservation District.

b. Includes the cities of Clayton, Concord, El Cerrito, Hercules, Lafayette, Martinez, Orinda, Pinole, Pittsburg, Pleasant Hill, Richmond, San Pablo, San Ramon, and Walnut Creek, the towns of Danville and Moraga, Contra Costa County, the Contra Costa County Flood Control and Water Conservation District.

c. Includes the cities of Campbell, Cupertino, Los Altos, Milpitas, Monte Sereno, Mountain View, Palo Alto, San Jose, Santa Clara, Saratoga, and Sunnyvale, the towns of Los Altos Hills and Los Gatos, the Santa Clara Valley Water District, and Santa Clara County.

d. Includes the cities of Belmont, Brisbane, Burlingame, Daly City, East Palo Alto, Foster City, Half Moon Bay, Menlo Park, Millbrae, Pacifica, Redwood City, San Bruno, San Carlos, San Mateo, and South San Francisco, the towns of Atherton, Colma, Hillsborough, Portola Valley, and Woodside, the San Mateo County Flood Control District, and San Mateo County.

e. Includes the cities of Fairfield and Suisun City.

4. Water Quality Program Assessment

Information about observed pesticide aquatic toxicity presented in the ANPR and summarized above indicates that CWA programs are not adequately protecting aquatic resource designated uses in the Bay Delta Estuary. California is identifying and addressing impairments using its delegated authority under the CWA in combination with state water and pesticide laws. California's efforts to reduce or eliminate pesticides as a source of aquatic toxicity and aquatic resource impairment through the ILRP, additional water quality criteria, TMDL implementation, and source controls are responsive and unparalleled in other states. We anticipate these efforts will produce water quality improvements once they are adopted and implemented.

It will be years before proposed TMDLs and DPR surface water regulations are adopted, implemented, and successfully reducing pesticide loadings to surface waters. TMDL programs generally have a compliance timeframe of 5 years from the date the TMDL programs are approved by EPA; however the Bay Delta Estuary remains on the 303(d) List of Impaired Waterbodies for aquatic resource impairments caused by diazinon and chlorpyrifos despite an adopted TMDL program. DPR plans to finalize its surface water regulations for professional urban applications of pyrethroids in late 2012. These rules are expected to result in an immediate reduction in urban runoff pyrethroid concentrations during the 2012/2013 storm season, but surface water regulations for other pesticides of concern are likely years away.

EPA has identified several actions to support California's groundbreaking work and to accelerate the restoration of pesticide impaired aquatic resource designated uses in the Bay Delta Estuary.

a. EPA Region 9 will assist the EPA Office of Pesticide Program (OPP) in the registration review process by identifying and providing California pesticide water quality data. By connecting water quality data to registration review, OPP can identify registered pesticides that are causing or contributing to water quality impairments and use this information to develop solutions under FIFRA that will reduce loadings of pesticides that cause aquatic resource impairments to waterways.

b. To further pesticide pollution prevention efforts, EPA will fund the San Francisco Estuary Partnership's (SFEP) Pesticide Reduction Campaign. SFEP will promote less toxic pesticide options through educating retail employees who sell pesticides as well as Bay area residents.

c. EPA will work with the Water Boards to minimize new sources of pesticide pollution in urban runoff by supporting the inclusion of measurable and enforceable LID requirements for new development and redevelopment in all MS4 permits. Information gathered from more than 50 audits EPA conducted over the last 10 years suggests that permits need to include clear, measurable requirements to be effective and enforceable. EPA will continue to review draft MS4 permits and MS4 implementation plans and will work with the Water Boards to ensure MS4 permits implement quantitative LID requirements. EPA comments to the SWRCB on the draft Phase II MS4 permit recommended that post-construction requirements, such as capturing, infiltrating, or evapotranspiring the 85th percentile storm event, apply to all MS4 permittees and new applicants seeking coverage under the general permit.[56] For the four Phase I MS4 permits in the Bay Delta Estuary that have expired or will expire before 2013 (Fresno, Stockton, Modesto, and Sacramento), EPA recommends that the Central Valley RWQCB incorporate LID provisions and define regulated projects consistent with recent MS4 permit updates (available at http://www.epa.gov/region9/water/lid/#ms4) as these permits are reissued.

d. If aquatic toxicity from urban runoff persists in the Bay Delta Estuary and its tributaries, EPA recommends evaluating the use of residual designation authority to establish a Delta Region Municipal MS4 permit. Such a permit would include multiple municipal jurisdictions from the counties or portions of the counties that encompass or directly drain to the Delta. This would establish consistency between Phase I and Phase II MS4 permitees that directly discharge to the Delta and simplify the storm water regulatory framework by having only 4 Phase I MS4 permits in the Bay Delta Estuary. These permits could be evaluated together to more easily determine what, if any, additional actions can be taken to reduce urban runoff volume, improve the quality of water transported through storm water systems, remove impairments caused by urban runoff, and protect designated uses.

e. To encourage LID as a means of minimizing pesticide pollution from new urban development, EPA recommends including LID requirements in CWA Section 401 Water Quality Certifications. CWA Section 401 applies to any development projects (residential, commercial, industrial) that require a CWA Section 404 permit from the Army Corps of Engineers. Water Quality Certifications can address urban runoff from new development and redevelopment and prevent further degradation of water quality by including conditions that are similar to post-construction LID requirements in the recently updated MS4 permits.

This would be particularly beneficial for new development at the fringe of cities covered under the Phase II MS4 General Permit as it may be outside the permit service area (e.g., city limits). The service area of the current Phase II MS4 General permit does not adjust as the city expands and develops within the permit cycle; it isn't adjusted until the next reissuance of the general permit, often after new developments are built and the opportunity to maximize LID designs is lost. In the Central Valley, the majority of new urban development built since the beginning of the 21st century was not designed or constructed using LID features or with the goal of maintaining predevelopment hydrology characteristics. The SWRCB recently issued a revised draft Phase II permit which would correct situation; EPA supports this revision.

Conditioning CWA Water Quality Certifications with LID requirements is also important in certain cities (Fresno, Stockton, Modesto, and Sacramento) covered by Phase I MS4 permits because it can occur presently, bridging the multi-year gap before reissuance of their next MS4 permits. Current Phase I MS4 permits for these cities do not include measurable and enforceable LID requirements, as were included in the East Contra Costa and San Francisco Bay Region permits. It may be many years before these permits are updated and reissued. Adding LID requirements into water quality certifications can occur quickly as new development is permitted.

Even after these new MS4 permits are issued, there may be value in continuing to reinforce LID requirements through Water Quality Certifications as new development is permitted under CWA Section 404. Maximizing the use of LID designs in new and redevelopment is an opportunity that should not be lost again as development continues to occur in the Central Valley and Bay Delta region.

f. EPA will continue to work with state and federal partners to address pesticide water pollution from urban and agricultural runoff by more strategically targeting pesticide BMPs. In particular, EPA will continue to support the Spatial and Temporal Modeling effort (described in #2 above) to prepare the model for others to use and to expand its scope to include flow transport. EPA will also participate in the Natural Resource Conservation Service's (NRCS) Bay Delta Landscape Accelerated Conservation Initiative with the goal of helping NRCS optimize pesticide load reductions and water quality improvements.

D. Contaminants of Emerging Concern

1. The Problem

Since 1980, more than 100,000 chemicals have been registered or approved for commercial use in the United States. These substances include more than 84,000 industrial chemicals, 9,000 food additives, 3,000 cosmetics ingredients, 1,000 active pesticide ingredients, and 3,000 pharmaceutical drugs. Although there may be laboratory data available at the time of registration, there is rarely comprehensive field data about the potential effects – especially the cumulative effects - that these chemicals might have on humans, fish and wildlife.

During the last decade, scientists began collecting data on the occurrence, fate, and toxicity of a variety of unregulated chemicals. New analytical methods for measuring trace quantities of contaminants in water (below parts per trillion) have led to frequent detection of previously unmonitored chemicals, such as pharmaceuticals and personal care products (PPCPs), current use pesticides, and industrial chemicals such as flame retardants and perfluorinated compounds (PFCs). These chemicals are now classified as contaminants of emerging concern (CECs) due to their high volume use, potential for toxicity in non-target species, and increasing occurrence in the environment.

CECs are introduced into the aquatic environment through a variety of sources including municipal and industrial wastewater systems, urban stormwater, animal husbandry operations, and agricultural runoff. Scientific methods for assessing the potential risks posed by CECs are not well established, yet evidence suggests that some CECs may be endocrine disrupting chemicals (EDCs) which can adversely affect organisms, their offspring, and/or subpopulations at very low concentrations. Specifically, EDCs can alter hormone levels, potentially resulting in the masculinization of female mollusks, the feminization of male fish, and reproductive effects.

2. CWA Program Response

CECs are not typically monitored in the environment, but the innovative Regional Monitoring Program (RMP) for Water Quality in the San Francisco Estuary (Bay RMP) has generated one of the most comprehensive datasets for CECs in aquatic ecosystems.[57] By comparison, studies on CECs in the Delta[58] remain nascent, and the Delta region still lacks the institutional structure necessary for duplicating the RMP's study of the Bay.

In October 2010, EPA recommended that the Central Valley RWQCB initiate a special study of CECs patterned after an approach pioneered by the Los Angeles RWQCB whereby certain wastewater dischargers (POTWs) are required to monitor for CECs in their effluent.[59] The Los Angeles RWQCB gave dischargers a list of minimum parameters to be monitored and established a process whereby the list could be updated and refined by the Southern California Coastal Water Research Project (SCCWRP).[60]

3. Public Comments

Commenters observed that since CECs enter waterways from a variety of sources (i.e., municipal and industrial wastewater, urban stormwater, confined animal feeding operations, and agricultural runoff), a comprehensive approach is needed for source control. Commenters expect EPA to play a significant role in characterizing the sources of CECs, monitoring (or at least studying) the environmental effects, screening products containing CECs, promoting environmentally safe alternatives, reducing inputs through regulatory and non-regulatory means, and advancing treatment technologies for removing trace concentrations of CECs from public water supplies. Commenters offered numerous information sources that could inform EPA's decisions about ways to control sources and evaluate the effects of CECs on aquatic resources.[61]

4. Program Assessment and Recommendations

Although there is insufficient data in the published literature to adequately assess the ecological implications of CECs in the Bay Delta Estuary, there is ample evidence to warrant additional attention. EPA has concluded that several additional actions would be worthwhile. Authorities beyond the CWA and State water quality laws are needed to fully address the problem.

a. EPA reiterates its recommendation that the Central Valley Regional Water Boards initiate a special study of targeted CECs patterned after the approach used by the Los Angeles Regional Water Board to require certain POTWs to monitor for minimum parameters in their effluent.

b. As resources become available, EPA will collaborate with agencies, industry, and non-governmental organizations to develop a monitoring[62] and source reduction strategy for those CECs that pose the greatest potential risk to the health of the Bay Delta Estuary. This effort should draw upon the source reduction approach created by the International Joint Commission for the Great Lakes[63] to identify sources of the targeted CECs; review available regulatory tools and technologies for directly addressing the sources of CECs; and detail regulatory and non-regulatory actions needed to control and eliminate discharges of CECs from the primary sources of CECs, such as more rigorous treatment of stormwater and incentivizing the return of unused PPCPs with lifecycle programs;[64]and implement control strategies..

c. EPA will participate in California Department of Toxic Substances Control (DTSC) toward advancing the implementation of the California Green Chemistry Initiative. Under California's proposed Safer Consumer Products regulations (which will be finalized in late 2012),[65] DTSC must identify priority chemicals in specific products that pose a significant hazard to human health or the environment. One of the criteria to be considered is whether those priority chemicals impact water quality or ecosystem health, in addition to posing hazards to human health. Selected chemical/products will be required to conduct a rigorous assessment of safer alternatives. Based on the results, DTSC could impose a range of regulatory sanctions, including increased testing and research, product labeling, or restrictions on use. EPA – including Region 9 – has signed a Memorandum of Understanding with DTSC to support their efforts to: 1) identify priority chemicals and products; 2) establish an alternative assessment methodology and process; and 3) promote green chemistry research and education. EPA Region 9 has already provided input to DTSC that priority CECs in the Bay and Delta should be considered in setting the initial list of priority chemicals and products.

d. Under the Toxic Substances Control Act (TSCA), EPA's Office of Chemical Safety and

Pollution Prevention in Washington D.C. is using existing authorities and information to address CECs at the national level.[66] Under the TSCA, EPA can take a variety of actions to address CECs, such as requiring greater testing on health and environmental impacts, implementing import or use restrictions or phase outs, and exploring and incentivizing safer alternatives. Nationally, EPA is evaluating the risks posed by selected chemicals and identifying specific steps the Agency will take to address these risks. To date, this national EPA effort has developed action plans for the following CECs known to occur in the Bay Delta Estuary: brominated flame retardants, perfluorinated compounds, phthalates, nonylphenol, and nonylphenol ethoxylates.

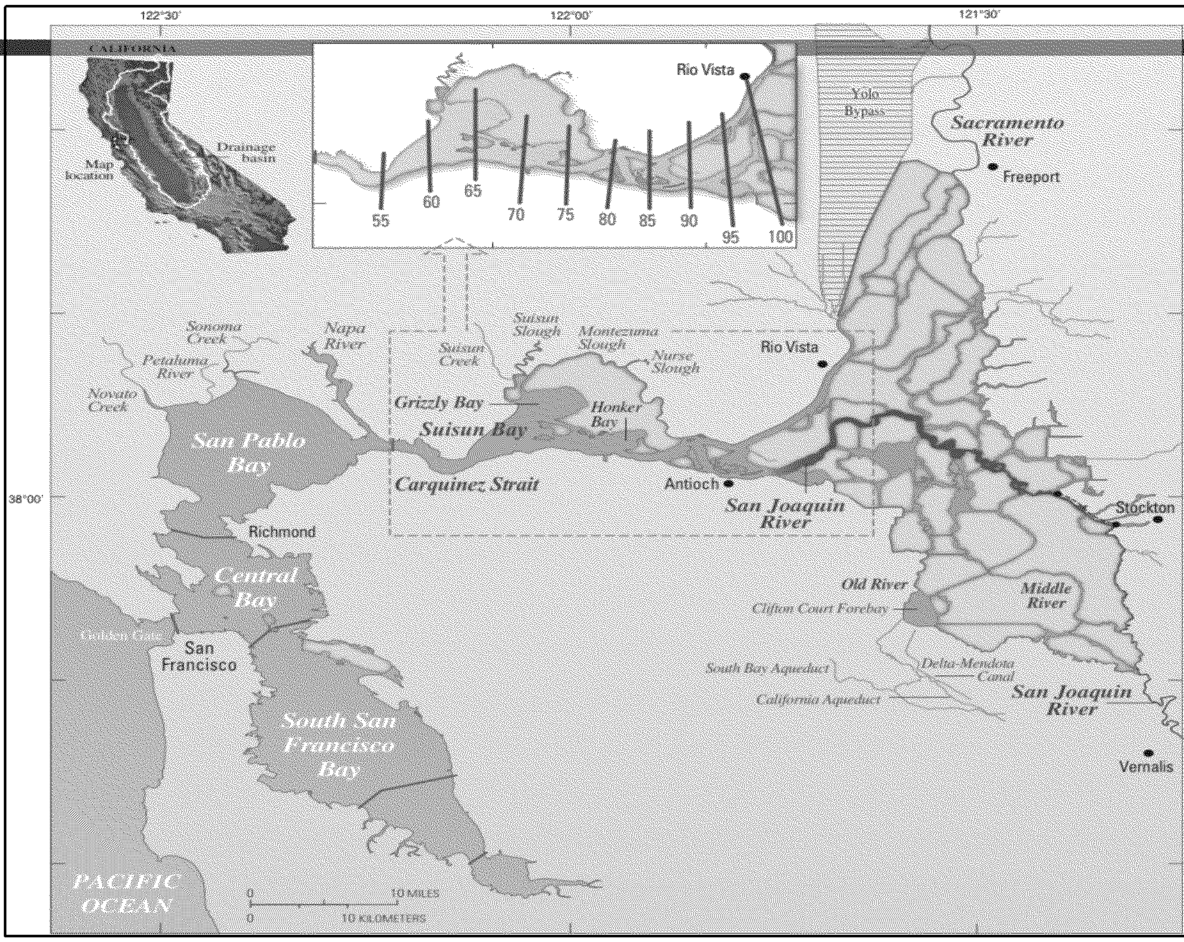


Figure 1. Isohaline positions (X2) measured at nominal distances (in kilometers) from the Golden Gate Bridge along the axis of the estuary. New map by DeLio (2011) adapted from Jassby et al. (1995). An isohaline is a line on a map connecting all points of equal salinity in an estuary, and it moves eastward (landward) and westward (seaward) depending on the flows and tides described above.

E. Estuarine Habitat

1. The Problem

An estuary is where river water mixes with seawater in a semi-enclosed basin. The area where these waters first mix is important habitat for diverse aquatic life in many estuaries, including the Bay Delta Estuary. The mixing of seawater with relatively lighter freshwater concentrates food, suspended sediments, and fish larvae in an area where salinity ranges from 2-6 ppt. This low salinity zone (LSZ) is an important nursery for young fish because high food density allows high growth rates and high turbidity protects young fish from predators. More saline parts of the Bay Delta Estuary, including especially San Pablo Bay and San Francisco Bay, are important for spawning and maturation of a number of marine species like Pacific herring and Dungeness crabs, but the mechanisms supporting those species are quite different from those of the LSZ. Many estuarine organisms show greater abundance or improved survival when the LSZ zone is in the broad, complex shallows of Suisun Bay rather than in the simple, rock-lined channels of the Western Delta.[67] For convenience, the location of the LSZ is indexed by the location of its upstream edge, i.e. the distance in km from the Golden Gate Bridge to the point where average daily salinity is 2 ppt; this distance is referred to as X2[68] (see Figure 1).

Some species that show a relationship with X2 are found in greatest abundance in the actual

Young pelagic fish of the upper estuary have been at record low levels for the past 10 years, although preliminary data suggest that many showed improvement after the very wet conditions of 2011. Over a 40 year period, trends in water clarity, low salinity zone location, and the volume of water exported were predictors of abundance for several species.[69] Conversely, a life cycle model for delta smelt implicated predation, temperature and food abundance in the decline of that species, but not with position of the LSZ.[70]

The areal extent of the LSZ varies greatly with different values of X2, based on hydrodynamic modeling (see Figures 2–5 below).[71] Different positions of the isohaline (corresponding to current springtime regulatory compliance points) produce very different quantities of estuarine habitat available to fish and wildlife.

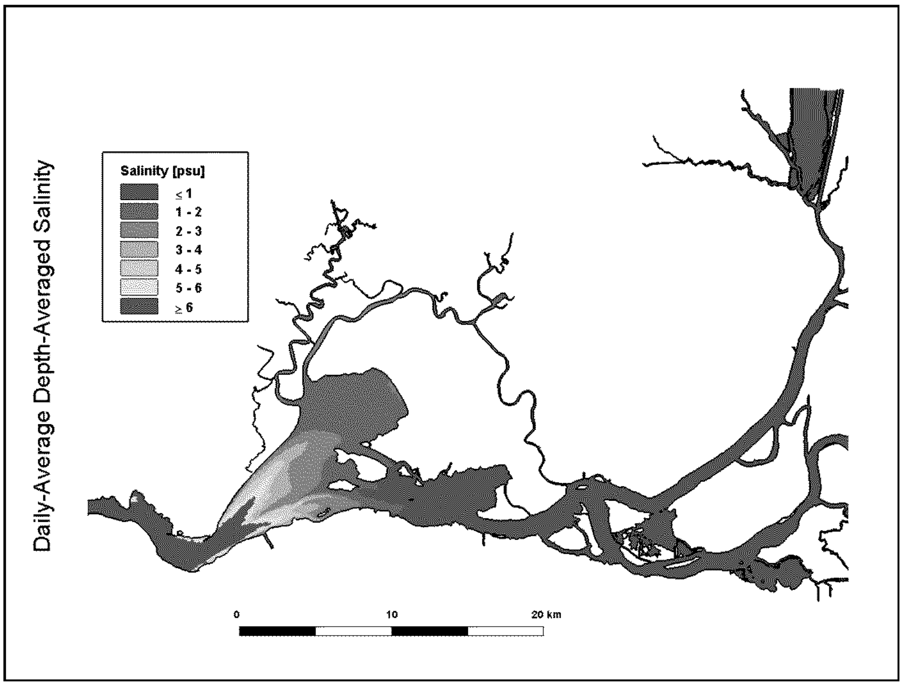


Figure 2. When X2 = 65 km (downstream of Roe Island), the low salinity zone (in shades of blue from 1-6 psu or ppt) stretches across the broadest regions of Suisun Bay adjacent to Suisun Marsh and covers 7704 hectares.

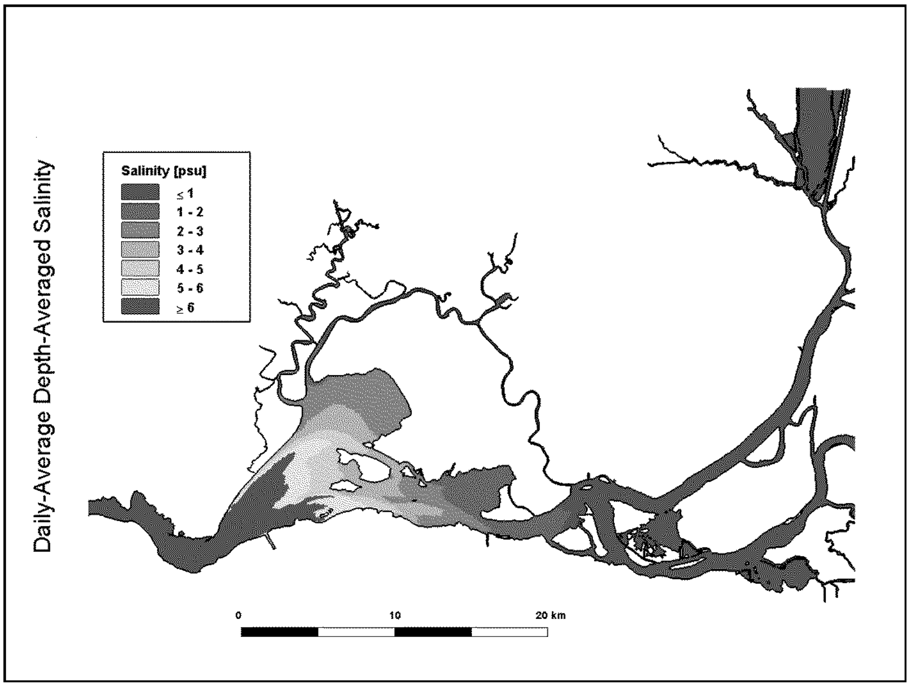


Figure 3. When X2 = 74 km (at Chipps Island), the low salinity zone increases to 9140 hectares, but it is less optimal with higher salinities in Grizzly Bay and the lowest salinities squeezed into smaller Honker Bay.

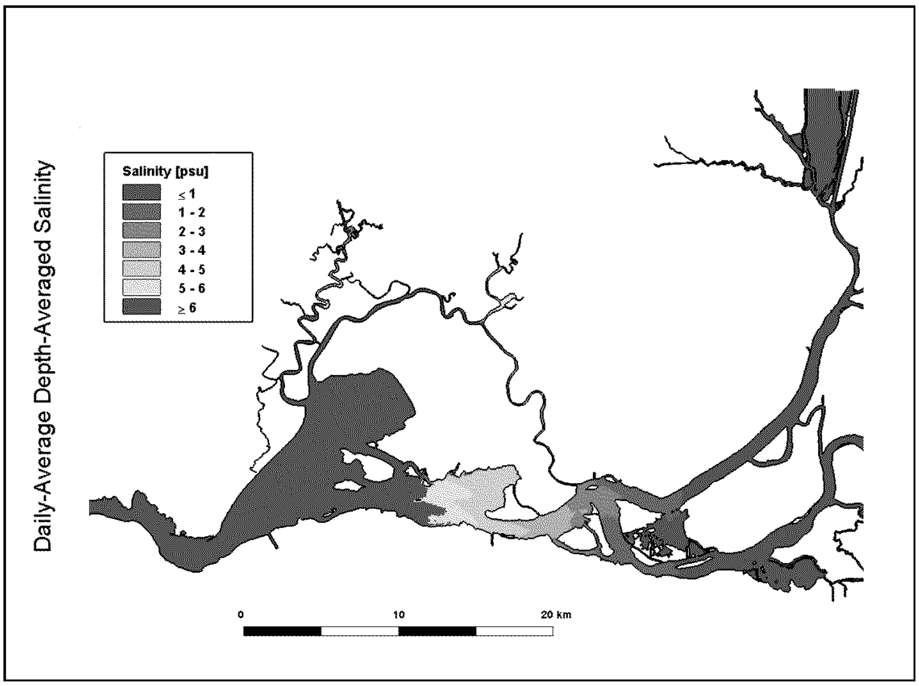


Figure 4. When X2 = 81 km (at the confluence of the Sacramento and San Joaquin rivers), the low salinity zone is compressed into the relatively deep river channels of the Western Delta where the areal extent of estuarine habitat drops to 4914 hectares.

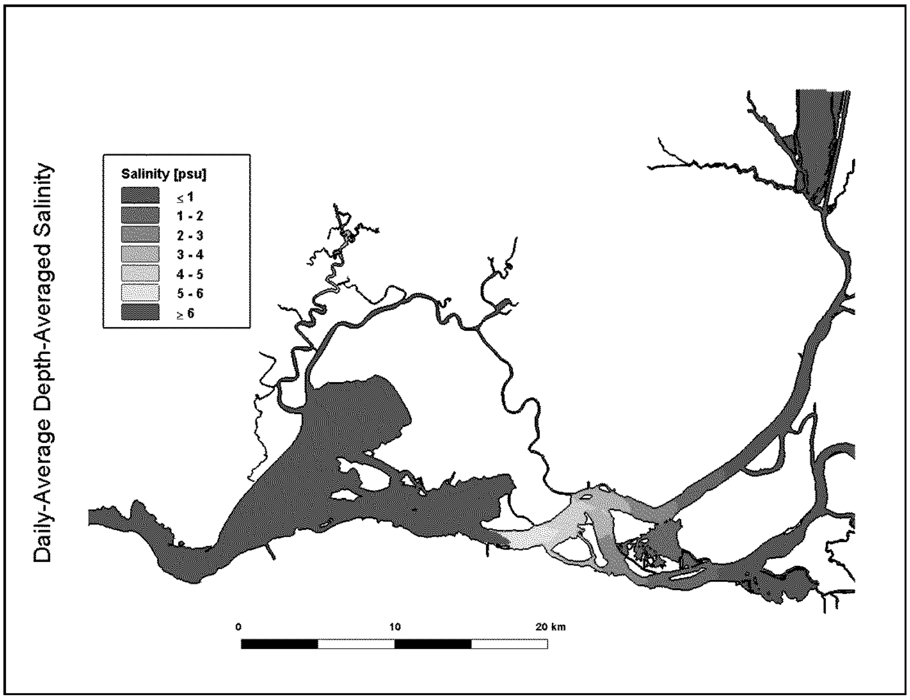


Figure 5. When X2 = 85 km, the isohaline approaches Antioch, and all connections to Suisun Bay and Marsh are lost. A relatively high salinity zone moves into Suisun, Grizzly, and Honker Bays; and the areal extent of estuarine habitat drops to 4262 hectares.

The location of the LSZ is controlled by the interaction between natural hydrology and export operations. Although most noticeable since 2000, the LSZ has shifted upstream since 1967 and has resulted in a substantial loss of estuarine habitat, with the change most pronounced following wet or above normal water years.[72] Water export from the delta in fall months has increased by about 1 million acre-feet since 2001. These increased exports have decreased delta outflow and fixed the low salinity zone in the Western Delta (except for fall 2011 when reservoir releases were sufficient to both support record exports and substantially increase delta outflow). Consequently, from 2001 to 2010, areas of suitable habitat in the fall shrank, compared to earlier years. This seasonal loss of estuarine habitat has coincided with the long-term decline in delta smelt abundance[73] and may be an important limiting factor in the survival of young striped bass and possibly young longfin smelt.[74]

This change in estuarine habitat is not only adverse for valued pelagic fishes, but advantageous to invasive species. The relatively stable, non-fluctuating salinity conditions in the Bay Delta Estuary have favored the colonization and explosion of non-native species populations, including Brazilian waterweed, blue-green algae, jellyfish, and overbite clams.[75] In addition, the increased spread of Brazilian waterweed (*Egeria densa*) has promoted the spread of predators, such as largemouth bass that live in such submerged aquatic vegetation (SAV). The effect of this widespread SAV on turbidity may be a part of a larger “regime shift” in the Estuary favoring invasives.[76] Thus, the stabilization in recent years of the low salinity zone in the western delta affects the low salinity ecosystem not only by shrinking its area in favor of conditions better suited for invasive species but by moving it eastward.

Eastward locations of the LSZ put its occupants at greater risk of the effects of urban and agricultural contaminants by putting them closer to the major cities of Sacramento and Stockton and river waters unmixed with relatively clean ocean waters.[77] Ammonium, which is primarily derived from the Sacramento Wastewater Treatment Plant, decreases in concentration downstream. Delta smelt, at least, are quite sensitive to its toxic effects.[78] Ammonium's impacts on phytoplankton may be felt as far downstream as San Pablo Bay.[79] At the same time, however, an earlier analysis of ammonium as a primary explanation of delta smelt decline[80] was subsequently questioned.[81]

The eastward movement of the low salinity zone is putting more of its occupants at risk of entrainment. Measured entrainment at the water export facilities is low through the summer and fall, but high temperatures, high predation rates, *Microcystis* blooms, and high agricultural discharge of poor quality water may not allow any affected fish to survive to the fish salvage facilities to be counted.

2. CWA Program Response

In 1991, the SWRCB designated Estuarine Habitat as a beneficial use of the waters in the Bay Delta Estuary. In 1995, the SWRCB established a Delta outflow standard designed to protect estuarine habitat and fisheries. This outflow standard was designed to mimic the relationship between springtime precipitation and the geographic location and extent of estuarine habitat as had occurred in the late 1960s and early 1970s.[82] This standard was adopted as a springtime standard only; no attempt was made at that time to define standards explicitly protecting the estuarine habitat designated use during other times of the year.

From 1995 to 1999, there was a significant recovery of migratory and resident Delta fish populations, probably due primarily to a series of wet springs and probably helped by the newly implemented water quality standards. In about 2000, however, many critical pelagic species suffered a dramatic decline (the "pelagic organism decline" or "POD"). This sudden and unexplained decline prompted wide ranging scientific investigations.[83]

In 2009, the SWRCB conducted a Periodic Review of the 2006 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta WQCP). The Periodic Review concluded that "[t]he available information indicates that further review and change of Delta outflow objectives may be required. Changes to Delta outflow patterns have likely contributed to the POD and are likely having an impact on the abundance of other species of concern…Based on current scientific information, recent regulatory actions, and expected recommendations from agencies and stakeholder groups, staff recommends the State Water Board conduct a detailed review of the Delta outflow objectives for possible revisions to the Bay-Delta Plan. Any revisions should also consider the need for Delta inflows." The Delta outflow review was initiated in early 2012, with initial workshops scheduled in mid-2012 and a final Board decision proposed for late 2013.[84]

The Bay-Delta WQCP review has received significant attention. For example, the Delta Stewardship Council's draft Delta Plan, dated May 14, 2012, includes as a policy that the SWRCB adopt and implement updated flow objectives for the Delta by June 2014, and develop flow criteria for high-priority tributaries to the Delta by June 2018, calling this "key to the achievement of the coequal goals."[85]

In August 2010, in a related but distinct effort mandated by the Delta Reform Act of 2009, the SWRCB approved a report determining new flow criteria for the Bay Delta Estuary necessary to protect public trust resources.[86] These recommendations, which by themselves have no legal effect, incorporated X2 flow prescriptions for certain fall periods. These prescriptions were originally proposed in the 2008 USFWS Biological Opinions on project operations. A similar "Fall X2" provision was also recommended by the California Department of Fish and Game.[87]

3. Public Comments

Commenters on the ANPR expressed a wide range of opinions about the value of protecting estuarine habitat, the regulatory use of X2; and the value of further studies into the causal relationships between X2 with fish populations.

4. CWA Program Assessment and Recommendations

EPA believes the highest priority action to improve aquatic resource protection in the Bay Delta Estuary is the SWRCB's review and modification of estuarine habitat protection standards in the Bay-Delta WQCP. EPA will assist the SWRCB in evaluating recent scientific work as it considers new standards to protect estuarine habitat.

To support this work, on March 27, 2012, EPA and the Aquatic Science Center invited a group of scientists to review relevant scientific literature since 1995 and consider new approaches to modeling the Estuary's functions. The workshop materials and the facilitator's report on the workshop will be provided to the SWRCB for its consideration. EPA will evaluate comments received at the workshop, as well as comments EPA received in response to the ANPR, as it develops recommendations to the SWRCB on future Delta standards.

In reviewing the current standards, EPA recommends the Board consider whether a year-round Estuarine Habitat standard is appropriate. Estuarine habitat was explicitly protected from February through June in the 1995/2006 Bay-Delta WQCP. Changes in water project operations in the last decade significantly altered the extent of estuarine habitat in the fall. Proposed changes in operations and Delta configuration could significantly change the extent of estuarine habitat in wetter months. Taking a comprehensive approach to the year-round needs of valued species will allow more effective long-term planning. As the water diversion and storage facilities in the Delta and upstream become more sophisticated and powerful, the SWRCB should explicitly acknowledge that its water quality and water rights functions are literally defining the Estuary – where it is located, how it operates, what characteristics it will have. Whereas a standard focused on one important period of the year made sense twenty years ago, recent improvements in Delta water export capabilities mean that the SWRCB's decisions will determine the nature of the Delta for most months of most years. This 12-month scope of review does not necessarily mean that the SWRCB would impose new restrictions throughout the year. Nevertheless, the SWRCB must consider how the Bay Delta Estuary works in different ways throughout the annual cycle and should adopt a comprehensive flow regime that encourages and protects healthy estuarine functions for all of the aquatic uses of this resource.

EPA also recommends that the SWRCB develop an appropriate suite of biological indicators and monitoring protocols to support any revised water quality standards. The draft "Framework for a Unified Monitoring, Assessment and Reporting Program for the Bay-Delta" report[88] recently submitted to the Delta Science Program may be useful in this regard.

F. Fish Migration Corridors

1. The Problem

Migratory fish rely on diverse habitats during different life stages and they require appropriate cues and connections to guide them to those habitats. Juvenile salmon use flow as the primary cue to maneuver from their spawning grounds through the rivers to the estuary. Salinity gradients and tidal action can then guide them to the ocean. Adult fish follow the unique chemical signature of their natal stream, although straying is common. Along these migratory paths, contaminants, high temperatures, low dissolved oxygen, physical barriers, and predators may interfere with migratory success. Thus, salmon management requires a watershed approach to ensure a connected and unblocked migratory corridor.

Fall-run Chinook salmon, the only remaining Chinook salmon population in the San Joaquin basin, are able to spawn below dams on the three main tributaries to the lower San Joaquin River (the Stanislaus, Tuolumne, and Merced Rivers). Although presently not listed under the Endangered Species Act, their abundance has declined sharply in the last 10 years.[89] Each year, young salmon migrate to the ocean from March to June, and mature adults return through the Delta from October through December. Central Valley steelhead begin their upstream migration as early as July and continue through April, with peaks in October and February. Their outmigration begins between Late December and July, with peaks between March and April.

Throughout the year, but particularly in the fall, San Joaquin River water is diverted and exported near the point where it enters the Delta.[90] The 1995 Bay-Delta WQCP required that exports during 31 days of the juvenile San Joaquin salmon spring outmigration period not exceed San Joaquin River inflow. The Vernalis Adaptive Management Plan (VAMP) – an implementation measure for the Bay-Delta WQCP that was formally adopted in 2006 - ensured that exports were always less than half of the inflow for the 31 day spring period. However, for the rest of the year, exports usually greatly exceed San Joaquin inflow. For the period of adult upmigration, the exports have usually been more than quintuple the inflow. Thus, the San Joaquin River channels in the Delta contain almost exclusively water from the Sacramento River, with little or no chemical trace of the natal spawning streams of San Joaquin salmon.

2. CWA Program Response

Most of the regulatory response protecting migratory fish in the Bay Delta Estuary has focused on helping juveniles migrate from their natal streams through the Estuary to the ocean, including the VAMP which was designed to gain additional scientific information on the flow needs of outmigrating salmonids on which to base future changes to the Bay-Delta WQCP. The SWRCB expects to amend the Bay-Delta WQCP with new San Joaquin River flow objectives in early 2013. The draft staff report for San Joaquin flows makes no recommendations addressing the upmigration of adults.[91] The SWRCB 's August 2010 Flow Criteria report identified the absence of a migratory corridor for returning adult salmon as an issue requiring attention.[92] The 2009 NMFS Biological Opinion on water export project operations requires that a pulse flow be released down the Stanislaus River to attract returning adult steelhead in October, but no requirement exists to extend this attraction pulse flow downstream beyond the confluence of the Stanislaus and the mainstem San Joaquin River.

In 2012, the Board will begin evaluating Delta conditions, including those needed to cue the upstream migration of salmon through the Delta, with a Board decision on any new or revised Bay-Delta WQCP changes scheduled for late 2013.

Additional regulatory efforts under the CWA to aid returning adult salmon have focused on particular migratory barriers, including high temperatures. In 2010, EPA listed several segments of the lower San Joaquin and tributaries as impaired (for purposes of CWA Section 303(d)) because of the impacts of high temperatures on salmon migration.[93] Similarly, the adverse effects of low dissolved oxygen in the Stockton Ship Channel have been the subject of both a TMDL (adopted by the Regional Board in 2005 and approved by EPA in 2007) and of several implementation measures designed to eliminate this block to fish migration.[94]

3. Public Comments

Some comments supported using diverse metrics to assess various aspects and impairments of a migration corridor. Impairments cited include water quality degradation (temperature, dissolved oxygen, contaminants), flow direction, physical barriers like the Fremont Weir and Suisun Marsh Salinity Control Gates, or physical structures that produce "hotspots" of predation. Habitat complexity, especially access to wetland and floodplain habitats, can also drive migratory success. Developing both biological response measures and water quality criteria was stressed. Some comments suggest that the controls on successful migration are inadequately known to justify changes to current flow and export requirements, while others expressed skepticism that short, low levels of export reduction could adequately ensure a migratory cue for adults. Most agreed that the timing of protection should be tied to the greatest biological sensitivity and that this might change from year to year.

4. CWA Program Assessment and Recommendations

Migratory passage along the San Joaquin River is a beneficial use that may not be adequately protected. Outmigrating juveniles have some protection; adults migrating back to their natal streams have little protection. The absence of migratory cues for returning adult San Joaquin fish has not been comprehensively addressed in a regulatory framework.

Although critical, the remediation of temperature and dissolved oxygen alone is unlikely to restore depleted salmon stocks unless water from the San Joaquin River and its tributaries supports a migratory corridor to and from the Estuary during both the season of adult upmigration and young outmigration. Both seasons consist of several months (March-June for juveniles and October to December for most adults) but adults can move through the delta in less than 2 days, whereas juveniles require approximately 2 weeks. Research[95] suggests that a short period of connection may be adequate to sustain the beneficial use.

a. EPA supports the work of the SWRCB to establish objectives for the San Joaquin River and the Delta that result in conditions which establish a migratory corridor for both juvenile and adult salmon. While the Board's proposed San Joaquin flows may adequately address the needs of outmigrating juveniles, revised Delta objectives must ensure that adult salmon have sufficient cues to navigate from the ocean through the Delta channels to the San Joaquin in the fall.

b. EPA will provide technical support to the SWRCB to develop a robust set of indicators for successful salmon migration. The science in this area continues to evolve, especially with the widespread use of sonic tagging to track the routes and rates and fates of migrating young and adult salmon. The draft "Framework for a Unified Monitoring, Assessment and Reporting Program for the Bay-Delta"[96] submitted to the Delta Science Program may be useful in developing both a suite of indicators and a monitoring program to support them.

c. EPA will work with the SWRCB, the Central Valley RWQCB, the California Department of Fish and Game (CDFG), and NOAA-Fisheries to address temperature impairments on the San Joaquin River and its tributaries. This might include a TMDL or other more effective regulatory mechanism(s). With their diverse and broad authorities, the Water Boards are best able to compel needed temperature reductions on the San Joaquin tributaries while restori a complete migration corridor for juveniles as well as adults. Given the SWRCB's comprehensive authorities – which include water quality standards, CWA Section 401 certification for hydropower facilities, and water rights – the SWRCB should coordinate a watershed approach to the protection of San Joaquin basin salmon.

G. Wetlands, Floodplain and Riparian Corridors

1. The Problem

Beginning in the 1850s, settlers diked, drained, and converted the floodplains, riparian corridors, and wetlands of the Bay Delta watershed into farms, cities and suburbs. (See Figure 6) A diversity of unique natural communities were destroyed and displaced, along with the fish and wildlife they supported. The losses include approximately 313,000 acres of wetlands in the Delta,[97] 637,000 acres of riparian forest along the Sacramento River, and 329,000 acres of riparian forest along the San Joaquin River.[98]

Throughout the watershed, levees were built near creeks and rivers, thereby disconnecting them from their historical floodplains. Consequently, the floodplains that once provided valuable rearing and foraging habitat for fishes when seasonally inundated were converted to other uses.[99] In addition, the loss of wetlands, floodplains, and riparian corridors greatly diminished the ability of these areas to accommodate flooding and recharge groundwater aquifers. Anticipated effects of climate change – including rising sea levels and more intense rainfall events – may exacerbate the ecological and flood control problems associated with the conversion of these aquatic habitats.[100] Also lost was the water quality improvement function that wetlands perform, capturing and filtering sediments, nutrients, and other pollutants.

Restoring wetlands in and near the Delta is an essential component of reviving the Estuary's health. However, nearly all the locations targeted for habitat restoration in the Delta have been, or are at risk of being, contaminated with mercury from historical mining sources and ongoing air deposition from industry. This mercury can be transformed into MeHg by the anaerobic (low oxygen) conditions prevalent in wetlands. This toxic form of mercury can accumulate in aquatic organisms and people that eat certain fish. Health advisories have been issued for the Delta and several upstream rivers. Given the long-term benefits of restoring aquatic habitats in the Delta (as well as the health benefits of eating fish), preventing the formation and mobilization of methylmercury in wetlands is critical. Scientific methods are being explored to prevent MeHg formation.[101]

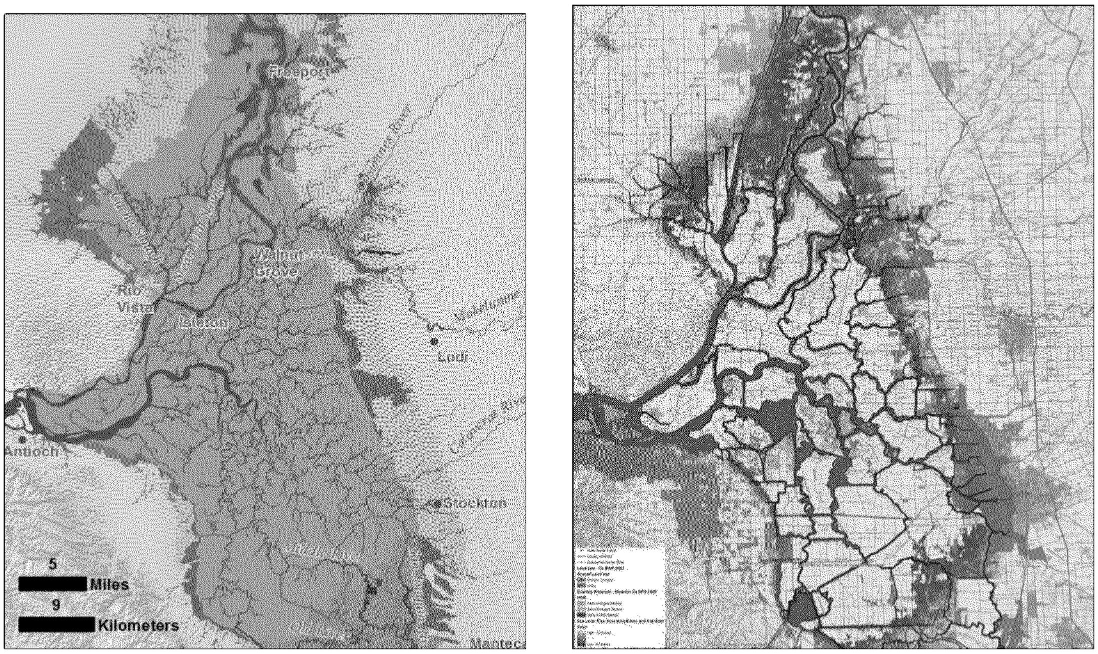


Figure 6: The Delta before and after diking and draining. The draft map of the Delta in the early 1880s on the left is courtesy of Grossinger and Whipple, SFEI (2012). The map of the post-modification, modern day Delta on the right was drawn from USBR-ESRI.[102]

2. CWA Program Response

The Clean Water Act addresses the loss of wetlands through both regulatory and nonregulatory programs. The federal Clean Water Act Section 404 established a program to regulate the discharge of dredged or fill material into waters of the United States, including wetlands. The Corps serves as the permit-writing agency for this program while EPA provides oversight.[103] The scope of the federal wetlands program has always been limited to "waters of the United States" and not to the surrounding uplands that might support the wetlands structurally and ecologically. California has authority under state law to assert jurisdiction over waters that are not covered by the federal program by declaring them "waters of the State."[104]

In addition to its regulatory role, EPA has modest funding to encourage conservation and restoration programs. EPA has provided funding to the SWRCB and CDFG to establish a state wetlands conservation program.[105] EPA has also participated with partners in identifying and funding individual wetlands restoration projects.

3. Public comments

Commenters pointed to the occurrence of relatively abundant native fish populations in proximity to tidally influenced wetlands (e.g., Suisun Marsh), and recommended using a functional approach to manage, regulate, and restore wetlands (including subsided Delta islands). This would entail protecting both aquatic and terrestrial landscapes and the underlying processes necessary for the formation, maintenance, evolution, and movement of wetlands across the landscape. Commenters asked EPA to be mindful of numerous factors including hydro-bio-geomorphology, the interface of wetlands and uplands, climate change, and sea level rise. A number of comments discussed the problem of mercury methylation. Preventing the formation and mobilization of methylmercury will be a difficult task as multiple agencies and other stakeholders pursue the restoration of wetlands, floodplains, and riparian habitats in the Delta.

4. CWA Program Assessment and Recommendations

The Corps and EPA administer the CWA Section 404 dredge and fill permitting program so that developers and infrastructure-building agencies avoid and minimize damage to aquatic resources and implement mitigation projects to compensate for unavoidable impacts.[106] The federal wetlands regulatory program is, by design, a reactive, "damage control" instrument, triggered only when an application to fill wetlands is received by the Corps. The Corps and EPA rarely prevent proposed projects from proceeding, and instead focus on ensuring proposed projects are properly sited and designed, and that compensatory mitigation is implemented, monitored, and managed.

Beginning in 1988, this damage control framework of the regulatory program was reinforced by federal and State no-net loss policies. Later, non-regulatory initiatives were proposed to achieve net gains in the nation's base of wetlands, in large part through conservation programs administered by NRCS under the federal Farm Bill. The result of these initiatives has been the subject of spirited debate.[107]

The CWA Section 404 wetlands regulatory program has slowed the degradation of aquatic habitats in the Bay Delta Estuary, but most observers agree that the regulatory program alone is unlikely to preserve and/or restore sufficient aquatic habitat to reverse the decline in fish and wildlife populations. During the period 1997-2004, the CALFED Bay-Delta Program invested more than $500 million to protect and restore over 130,000 acres of habitat in the Bay Delta watershed and conserved another 54,000 acres of agricultural lands.[108] Even so, members of the CALFED Independent Science Board concluded that these environmental gains remained overshadowed by the magnitude of historical degradation, and that political and economic realities continued to constrain the scale of corrective action. Furthermore, the Science Board accepted the fact that environmental improvements would be made incrementally with the design and implementation of many restoration projects, and called for a more rigorous framework for prioritizing and evaluating the long-term, cumulative effects of multiple small projects.[109]

To build upon the CALFED restoration work, EPA will work with the Corps to refine the framework for regulating discharges of fill material to waters of the United States and waters of the State, and encourage and contribute to the restoration of a diverse portfolio of aquatic habitats within the Bay Delta Estuary. The latter goal entails restoring aquatic habitats on the sunken islands of the central and western Delta, and the higher elevation landscapes of the northern and southern Delta. The restoration areas favored by EPA partially overlap with those identified in the BDCP process, with EPA underscoring the importance of reversing subsidence on islands in the central and western Delta – especially on islands partially or wholly owned by the State (See Figure 7).[110] Restoring aquatic habitats in the Delta will have multiple benefits including: (1) increasing the system's carrying capacity for floodwaters; (2) creating suitable habitat necessary for the recovery of fish and wildlife populations; (3) rebuilding peat soils, sequestering greenhouse gases, reversing the subsidence of sunken Delta islands, and stabilizing Delta levees.[111]

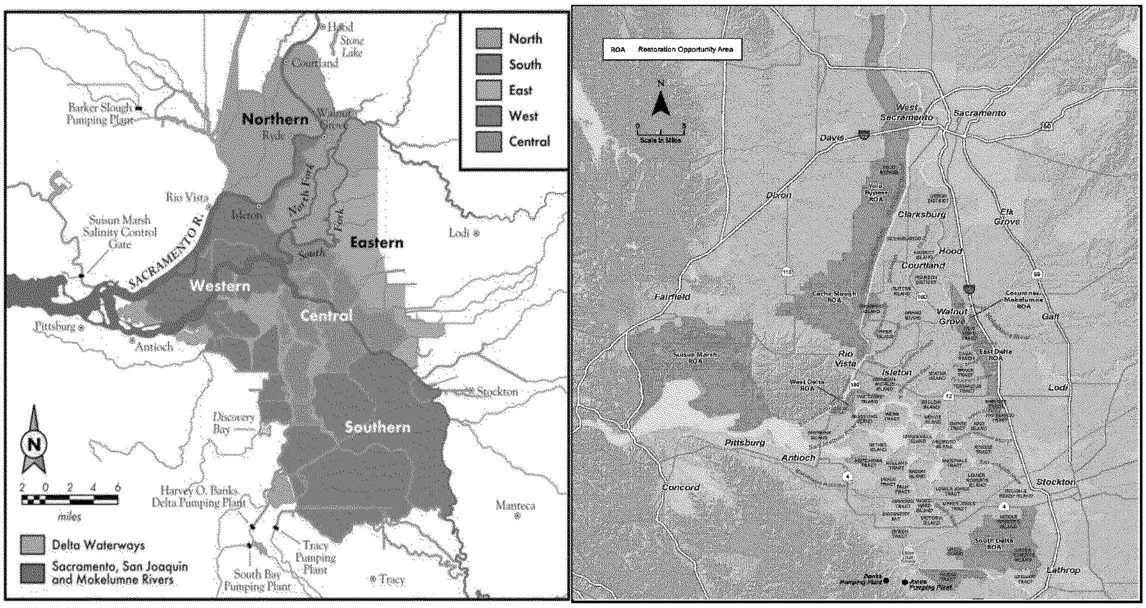


Figure 7. The map on the left depicts the geographical regions of the Delta (as illustrated by the PPIC). The map on the right depicts potential Restoration Opportunity Areas (ROAs) per the BDCP process.

a. EPA will continue collaborating with the SWRCB and the Corps to create more effective regulatory programs for protecting aquatic habitats of the Bay Delta Estuary under the federal Clean Water Act, specifically:

(i) State Regulatory Programs: EPA will continue supporting the SWRCB in their preparation of a State Wetlands Policy to ensure adequate protection for aquatic habitats statewide.

(ii) Federal Regulatory Programs: EPA will encourage the Corps to:

(1) deny applications for filling regulated waters on open lands where habitat could be restored or agricultural practices improved to advance the recovery of fish and wildlife populations (i.e., within the primary and secondary zones of the Delta, on lands adjoining the Sutter and Yolo bypasses, and on flood prone lands within the San Joaquin River watershed);[112]

(2) designate mitigation sites at strategic locations in the Bay Delta region, and encourage permit applicants to choose these mitigation sites for off-setting the unavoidable adverse impacts of their developments;

(3) add terms and conditions to permits issued under CWA Section 404 that require permittees to comply with regulatory mandates under CWA Section 303 whenever they receive permission from the Corps to discharge dredged or fill material into impaired waters (e.g., terms and conditions for preventing the formation and transport of MeHg consistent with the Delta Methylmercury TMDL, and for contributing to the establishment of a regional monitoring plan for the Delta[113]); and

(4) promote the beneficial re-use of clean dredged material within the Delta to strengthen levees

where appropriate and to restore aquatic habitats in upland areas where compressible peat soils are not present.[114]

b. EPA will continue collaborating with agencies and NGOs to restore aquatic habitats in the Bay Delta watershed, helping to ensure that restoration plans are designed and implemented to maximize benefits to human health and the environment, address potential threats and trade-offs attendant to the restoration actions, and share lessons learned to bolster adaptive management of the ecosystem. The following section highlights specific projects within selected geographic locations.

(i) Dutch Slough Restoration Project (Contra Costa County): The California Coastal Conservancy is spearheading the restoration of tidal marsh and related habitats on the 1,166-acre Dutch Slough property where Marsh Creek enters the Delta at Big Break.[115] The project site encompasses the Emerson parcel (438 acres), the Gilbert parcel (292 acres), and the Burroughs parcel (436 acres). EPA has participated in the Adaptive Management Working Group for the project, and has contributed $1.5 million to California Coastal Conservancy toward restoring the Emerson Parcel.[116]

Scientists and engineers from EPA will work with stakeholders to ensure MeHg is effectively managed at Dutch Slough during both the near-term restoration phase and the long-term stewardship phase. Marsh Creek receives acid mine drainage from the abandoned Mount Diablo Mercury Mine situated 30 miles upstream from Dutch Slough, and mercury-laden sediment occupies space within the Marsh Creek Reservoir upstream from Dutch Slough.[117] EPA possesses the unique capability to both contribute to the restoration of aquatic habitats at Dutch Slough, and the control of mercury sources within the Marsh Creek watershed.

The Dutch Slough Restoration Project presents stakeholders with: (1) a rare opportunity to restore tidal marsh and a floodplain on the delta of a creek; (2) the task of preventing the formation and transport of MeHg as anaerobic processes take hold on a newly restored tidal marsh; (3) the challenge of accommodating sea level rise; and (4) the obligation to share lessons learned with others who plan similar restoration projects in the Delta region.

(ii) Carbon Farms and Environmental Markets (Sacramento County): As resources allow, EPA will collaborate with DWR, USGS, the Delta Conservancy, and NGOs to establish a farm-scale sized Carbon Capture Wetland Farm modeled after USGS' Carbon Capture Farming Program.[118] USGS has demonstrated that growing tules and cattails can rebuild peat soils, reverse subsidence, and sequester CO_2. With DWR's support, USGS is now studying the methane emissions from the restored wetlands, and treatment options for dissolved organic carbon (DOC) to safeguard water quality. In addition, EPA will fund USGS to study whether the treatment technology used for DOC could be also used to sequester MeHg in the accreting wetlands (i.e., Low Intensity Chemical Dosing).

To provide farmers with financial incentives to grow peat-building vegetation and/or transition to low carbon agriculture, EPA will collaborate with agencies and NGOs to establish an environmental market in the Western Delta. The market could encompass State lands that are leased to farmers on Sherman and Twitchell Islands, and be designed to compensate farmers with revenue equal to or better than what they earn from commodity crops. The market would become self-sustaining and independent from government subsidies in the long-term following initial government investments to establish such a market.[119]

The market could generate revenue for farmers that reflects the economic value of ecosystem services produced by the tule and cattail-dominated wetlands (e.g., climate protection, subsidence reversal, levee stabilization, water supply security, farmland conservation, and wildlife habitat). Historically, such services have been undervalued or disregarded in economic decisions surrounding the development of natural resources.[120] The status quo approach to resource management over-values the benefits of development, under-values the diminishment of natural services resulting from an impaired ecosystem, and under-values the potential benefits of conservation and stewardship.

(iii) Yolo Bypass: EPA's water and hazardous waste programs will collaborate with stakeholders who have proposed restoration projects within the Yolo Bypass to ensure MeHg is effectively managed during both the near-term restoration phase and the long-term stewardship phase. The 59,000-acre Bypass was constructed as a flood control feature, and retains some of its pre-settlement floodplain functions as it supports 42 species of fish (15 native), 200 species of birds, and an abundance of phytoplankton and zooplankton.[121] Proposed projects include increasing the areal extent of aquatic habitat beyond that already contained in the Yolo Wildlife Area,[122] and renovating weirs that are harmful to fish.[123]

Sediments within some areas of the Bypass are contaminated with mercury, and could provide the substrate necessary for the formation of methylmercury.[124] Cache Creek transports mercury from abandoned and orphaned mercury mines in the Coast Range to the Cache Creek Settling Basin and eastward to the Bypass itself, and accounts for 60% of all the mercury discharged within the Central Valley.[125] EPA's hazardous waste program has already controlled mercury releases from the Abbott/Turkey Run Mine and the Sulphur Bank Mercury Mine at Clear Lake. EPA will build on these efforts to further reduce the environmental threats posed by methylmercury.[126]

(iv) Lower San Joaquin: EPA will collaborate with others to conserve historic floodplains and restore aquatic habitat along the Lower San Joaquin River in a manner that improves flood protection for agricultural landscapes and settlements, supports work underway and proposed throughout the San Joaquin River Basin.[127]

Endnotes:

[1] See "Staff Report: The Control of Agricultural Subsurface Drainage: Amendments to the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins," (March 1996) for the regulatory framework of selenium control in the San Joaquin basin. The three TMDLs were adopted for Salt and Mud Sloughs and the San Joaquin River between1999 and 2002. The TMDL program is discussed in detail in the ANPR.

[2] Grassland Bypass Project: http://www.sfei.org/grassland/

[3] *Potential Effects of Selenium Contamination on Federally-listed Species Resulting from Delivery of Federal Water to the San Luis Unit.* Beckon and Maurer (March 2008).
http://www.swrcb.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/exhibits/cwin/cwin_exh25.pdf

4

5 Theresa Presser & Samuel N. Luoma, *A Methodology for Ecosystem-Scale Modeling of Selenium* (2010). http://onlinelibrary.wiley.com/doi/10.1002/ieam.101/full.

6 The criteria, which are stated in terms of 'chronic' exposure, will amend the California Toxics Rule.

7 SAN FRANCISCO BAY REG'L WATER QUALITY CONTROL BD (2011) Total Maximum Daily Load Selenium in North San Francisco Bay Preliminary Project Report from Barbara Baginska, available at http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/northsfbayselenium/SeTMDL_PreliminaryReport_01-11.pdf.

8 CENT. VALLEY REG'L WATER QUALITY CONTROL BD (2009) Ammonia Summit Summary (Aug. 18-19, 2009), http://www.swrcb.ca.gov/rwqcb5/water_issues/delta_water_quality/ambient_ammonia_concentrations/index.shtml. ; CENT. VALLEY REG'L WATER QUALITY CONTROL BD (2010) Ammonia Update Memorandum from Christopher Foe, Cal. Reg'l Water Quality Bd. Cent. Valley Region to Jeff Bruns & Karen Taberski (Oct. 7, 2010), available at http://www.waterboards.ca.gov/centralvalley/water_issues/delta_water_quality/ambient_ammonia_concentrations/oct2010_staffupdate_ammonia.pdf; ADAM BALLARD ET AL., INTERAGENCY ECOLOGICAL PROGRAM, BACKGROUND/SUMMARY OF AMMONIA INVESTIGATIONS IN THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN BAY (2009), available at http://science.calwater.ca.gov/pdf/workshops/workshop_ammonia_bckgrnd_paper_nh4-nh3_030209.pdf; CENT. VALLEY REG'L WATER QUALITY CONTROL BD (2009) Ammonia Update Memorandum from Christopher Foe, Cal. Reg'l Water Quality Bd. Cent. Valley Region to Jeff Bruns & Sue McConnell, Water Boards (Sept. 24, 2009), available at http://www.waterboards.ca.gov/centralvalley/water_issues/delta_water_quality/ambient_ammonia_concentrations/ammonia_mem.pdf

9 Swee Teh, Ida Flores, Michelle Kawaguchi, Sarah Lesmeister, and Ching The (2011). Full Life-Cycle Bioassay Approach to Assess Chronic Exposure of *Pseudodiaptomus forbesi* to Ammonia/Ammonium. Final Report submitted to State Water Resources Control Board. *Available at http://www.swrcb.ca.gov/centralvalley/water_issues/delta_water_quality/ambient_ammonia_concentrations/tehetal_ammonium_exposure2011*.pdf; Alan Jassby, Phytoplankton in the Upper San Francisco Estuary: Recent Biomass Trends, their Causes, and their Trophic Significance, 6 SAN FRANCISCO ESTUARY & WATERSHED SCI. 1 (Feb. 2008), available at http://escholarship.org/uc/item/71h077r1; Richard C. Dugdale, F.P. Wilkerson, V.E. Hogue & A., Marchi, *The Role of Ammonium and Nitrate in Spring Bloom Development in San Francisco Bay*, 73 ESTUARINE, COASTAL & SHELF SCI. 17, 17-29 (2007); Frances P. Wilkerson et al., *Phytoplankton Blooms and Nitrogen Productivity in the San Francisco Bay*, 29(3) ESTUARIES & COASTS 401, 401-16 (2006).

10 Lehman, *The Influence of Climate on Phytoplankton Community Biomass in San Francisco Bay Estuary*, 45 LIMNOLOGY & OCEANOGRAPHY (3) 580, 580-90 (2000); Brown, *Phytoplankton Community Composition: The Rise of the Flagellates*, 22IEP NEWSLETTER (3) 20, 20-27 (2009), *available at* http://www.water.ca.gov/iep/newsletters/2009/IEPNewsletter_Final2SUMMER-Fall2009%20.pdf; J. E. Cloern & R. Dufford, *Phytoplankton Community Ecology: Principles Applied in San Francisco Bay*, 258 MARINE ECOLOGY PROGRESS SERIES 11, 11-28 (2005); Quay Dortch, *The Interaction Between Ammonium and Nitrate Uptake in Phytoplankton*, 61 MARINE ECOLOGY PROGRESS SERIES 183, 183-201(1990).

11 National Estuarine Experts Workgroup (2010) Nutrients in Estuaries Summary Report. November 2010. *Available at http://water.epa.gov/scitech/swguidance/standards/criteria/nutrients/upload/Nutrients-in-Estuaries-November-2010.pdf*; James Cloern (June 30, 2011) Presentation at SFEI Workshop on Nutrient Science and Management in San Francisco *Available at http://www.sfei.org/sites/default/files/03_Cloern_USGSMonitoring.pdf*

12 Eutrophication is a condition caused by excess nutrients in waterways, which cloud water blocking sunlight to submerged aquatic vegetation and feed algae causing massive blooms. When algae and submerged aquatic vegetation decompose they exhaust the supply of dissolved oxygen in the water needed to support aquatic life (e.g, fish and invertebrates).

13 The Nutrient Numeric Endpoints Development for San Francisco Estuary: Literature Review and Data Gaps Analysis. February 2011 Draft for Review. *Available at http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/amendments/estuarineNNE/SFBay%20NNE%20Literature%20Review%20Draft%20Final%204-27-%202011.pdf.*

14 CENT. VALLEY REG'L WATER QUALITY CONTROL BD., NPDES PERMIT RENEWAL ISSUES

AQUATIC LIFE AND WILDLIFE PRESERVATION SACRAMENTO REGIONAL COUNTY SANITATION DISTRICT SACRAMENTO REGIONAL WASTEWATER TREATMENT PLANT (Apr. 28, 2010), *available at* http://www.swrcb.ca.gov/centralvalley/board_decisions/tentative_orders/aquatictox/aquatictox_iss_pap.pdf; CENT. VALLEY REG'L WATER QUALITY CONTROL BD Sacramento County Regional Sanitation District, Regional Wastewater Treatment Plant, NPDES Permit Order 72 No. R5-2010-0014 (Dec. 9, 2010), *available at* http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/sacramento/r5-2010-0114_npdes.pdf.

[15] CENT. VALLEY REG'L WATER QUALITY CONTROL BD Sacramento County Regional Sanitation District, Regional Wastewater Treatment Plant, NPDES Permit Order 72 No. R5-2010-0014 (Dec. 9, 2010), *available at* http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/sacramento/r5-2010-0114_npdes.pdf.

[16] CENT. VALLEY REG'L WATER QUALITY CONTROL BD Sacramento County Regional Sanitation District, Regional Wastewater Treatment Plant, NPDES Permit Order 72 No. R5-2010-0014 (Dec. 9, 2010), *available at* http://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/sacramento/r5-2010-0114_npdes.pdf.

[17] SRCSD (2011) Petition to SWRCB to review CVRWQCB NPDES Permit R5-2010-0114 Decision. *Available at* http://www.waterboards.ca.gov/rwqcb5/water_issues/waste_to_surface_water/srcsd_petitions_responses/srcsd_petition.pdf

[18] STATE WATER RESOURCES CONTROL BOARD (May 14, 2012) Letter to Mr. Paul Simmons, Theresa Dunham, Aw-Yang and Bill Jennings regarding PETITIONS OF SACRAMENTO REGIONAL COUNTY SANITATION DISTRICT AND CALIFORNIA SPORTFISHING PROTECTION ALLIANCE (WASTE DISCHARGE REQUIREMENTS ORDER NO. R5-2010-0114 [NPDES NO. CA0077682] FOR THE SACRAMENTO REGIONAL COUNTY SANITATION DISTRICT, SACRAMENTO REGIONAL WASTEWATER TREATMENT PLANT, SACRAMENTO COUNTY), CENTRAL VALLEY WATER BOARD: BOARD WORKSHOP NOTIFICATION SWRCB/OCC FILES A-2144(a) and A-2144(b)

[19] SCCWRP March 2007 Technical Approach To Develop Nutrient Numeric Endpoints For California Estuaries. *Available at* *http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/planningtmdls/amendments/estuarineNNE/516_nutrient_numeric_endpoints_CA_estuaries.pdf*

[20] Delta Stewardship Council (May 14, 2012) Final Staff Draft Delta Plan. *Available at* http://deltacouncil.ca.gov/delta-plan/current-draft-of-delta-plan

[21] http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/pollutants/ammonia/factsheet2.cfm.

[22] U.S. ENVTL. PROT. AGENCY, DRAFT 2009 UPDATE AQUATIC LIFE AMBIENT WATER QUALITY CRITERIA FOR AMMONIA – FRESHWATER FACTSHEET (2009), *available at* http://www.epa.gov/waterscience/criteria/ammonia/factsheet2.html.

[23] STATE WATER RES. CONTROL BD., 2010 INTEGRATED REPORT CLEAN WATER ACT SECTIONS 303(D) AND 305(B) (Apr. 19, 2010), *available at* http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml

[24] CHRISTOPHER FOE & VALERIE CONNOR, STAFF REPORT CENT. VALLEY REG'L WATER QUALITY CONTROL BD., 1989 RICE SEASON TOXICITY MONITORING RESULTS (1991), *available at* http://www.calwater.ca.gov/Admin_Record/C-029766.pdf.; CHRISTOPHER FOE & VALERIE CONNOR, STAFF REPORT CENT. VALLEY REG'L WATER QUALITY CONTROL BD., SAN JOAQUIN WATERSHED BIOASSAY RESULTS, 1988-1990 (1991); Kathryn Kuivila & Christopher Foe, *Concentrations, Transport and Biological Effects of Dormant Spray Pesticides in the San Francisco Estuary, California*, 14 ENVTL. TOXICOLOGY & CHEMISTRY 1141, 1141-50 (1995); Howard C. Bailey et al., *Diazinon and Chlorpyrifos in Urban Waterways in Northern California, USA*, 19 ENVTL. TOXICOLOGY & CHEMISTRY 82, 82-87 (2000); VALERIE CONNOR, STAFF MEMORANDUM STATUS OF URBAN STORM RUNOFF PRODUCTS, ALGAL TOXICITY AND HERBICIDE LEVELS ASSOCIATED WITH URBAN STORM RUNOFF, DIAZINON AND CHLORPYRIFOS DETECTIONS IN THE SAN FRANCISCO BAY AREA, *as reported in* CHRISTOPHER FOE, STAFF REPORT CENT. VALLEY REG'L WATER QUALITY CONTROL BD., EVALUATION OF THE POTENTIAL IMPACT OF CONTAMINANTS ON AQUATIC RESOURCES IN THE CENTRAL VALLEY AND SACRAMENTO-SAN JOAQUIN DELTA ESTUARY (1995); CHRISTOPHER FOE, LINDA DEANOVIC & DAVE HINTON, STAFF REPORT CENT. VALLEY REG'L WATER QUALITY CONTROL BD. TOXICITY IDENTIFICATION EVALUATIONS OF ORCHARD DORMANT SPRAY RUNOFF (1998); CHRISTOPHER FOE & R. SHEIPLINE, STAFF REPORT CENT. VALLEY REG'L WATER QUALITY CONTROL BD., PESTICIDES IN SURFACE WATER FROM APPLICATIONS ON ORCHARDS AND ALFALFA DURING THE WINTER AND SPRING OF 1991-1992 (1993); Donald Weston & Michael J. Lydy, *Pyrethroid Insecticides to the Sacramento-San Joaquin Delta of California*, 44 ENVTL. SCI. & TECH. 1833, 1833-40 (2010).

[25] Examples of dry-weather flows are sprinklers, car wash, drinking water system flushes, pool emptying, car and

building, driveway, sidewalk washing.

[26] We use the term urban landscapes to refer to both urban core areas with very high impervious surface coverage and suburban/exurban areas that are developed into low density commercial and residential areas. It does not refer to agricultural areas or very low density rural residential/"ranchette" areas.

[27] URBAN PESTICIDE POLLUTION PREVENTION PROJECT, PESTICIDES OF INTEREST FOR URBAN SURFACE WATER QUALITY, URBAN PESTICIDES USE TRENDS ANNUAL REPORT (2008), *available at* http://www.up3project.org/documents/UP3UseTrendsReport2008.pdf.

[28] Phillip Reese "Sprawl's Spread Speeds Up" Sacramento Bee Nov 5, 2011 p. 1A. *Available at* http://www.sacbee.com/2011/11/05/4033576/sprawls-spread-speeds-up.html#mi_rss=Top%20Stories. See map of new development and caption "The Sacramento Region's urban footprint – areas with more than 1000 residents per square mile – grew by approximately 57,000 acres during the last decade…" Estimate is derived from census bureau data.

[29] CHRISTOPHER FOE & VALERIE CONNOR, STAFF REPORT CENT. VALLEY REG'L WATER QUALITY CONTROL BD., 1989 RICE SEASON TOXICITY MONITORING RESULTS (1991), *available at* http://www.calwater.ca.gov/Admin_Record/C-029766.pdf; CHRISTOPHER FOE & VALERIE CONNOR, STAFF REPORT CENT. VALLEY REG'L WATER QUALITY CONTROL BD., SAN JOAQUIN WATERSHED BIOASSAY RESULTS, 1988-1990 (1991). [201] Kathryn Kuivila & Christopher Foe, *Concentrations, Transport and Biological Effects of Dormant Spray Pesticides in the San Francisco Estuary, California*, 14 ENVTL. TOXICOLOGY & CHEMISTRY 1141, 1141-50 (1995); Howard C. Bailey et al., *Diazinon and Chlorpyrifos in Urban Waterways in Northern California, USA*, 19 ENVTL. TOXICOLOGY & CHEMISTRY 82, 82-87 (2000); VALERIE CONNOR, STAFF MEMORANDUM STATUS OF URBAN STORM RUNOFF PRODUCTS, ALGAL TOXICITY AND HERBICIDE LEVELS ASSOCIATED WITH URBAN STORM RUNOFF, DIAZINON AND CHLORPYRIFOS DETECTIONS IN THE SAN FRANCISCO BAY AREA, *as reported in* CHRISTOPHER FOE, STAFF REPORT CENT. VALLEY REG'L WATER QUALITY CONTROL BD., EVALUATION OF THE POTENTIAL IMPACT OF CONTAMINANTS ON AQUATIC RESOURCES IN THE CENTRAL VALLEY AND SACRAMENTO-SAN JOAQUIN DELTA ESTUARY (1995); CHRISTOPHER FOE, LINDA DEANOVIC & DAVE HINTON, STAFF REPORT CENT. VALLEY REG'L WATER QUALITY CONTROL BD. TOXICITY IDENTIFICATION EVALUATIONS OF ORCHARD DORMANT SPRAY RUNOFF (1998); CHRISTOPHER FOE & R. SHEIPLINE, STAFF REPORT CENT. VALLEY REG'L WATER QUALITY CONTROL BD., PESTICIDES IN SURFACE WATER FROM APPLICATIONS ON ORCHARDS AND ALFALFA DURING THE WINTER AND SPRING OF 1991-1992 (1993). Donald Weston & Michael J. Lydy, *Pyrethroid Insecticides to the Sacramento-San Joaquin Delta of California*, 44 ENVTL. SCI. & TECH. 1833, 1833-40 (2010).

[30] Donald Weston & Michael J. Lydy, *Pyrethroid Insecticides to the Sacramento-San Joaquin Delta of California*, 44 ENVTL. SCI. & TECH. 1833, 1833-40 (2010); Weston, D.P., R.W. Holmes, J. You, and M.J. Lydy. 2005. Aquatic toxicity due to residential use of pyrethroid insecticides. *Environ. Sci. & Technol*. 39: 9778-9784; Amweg, E.L., D.P. Weston, J. You, and M.J. Lydy. 2006. Pyrethroid insecticides and sediment toxicity in urban creeks from California and Tennessee. *Environ. Sci. & Technol*. Published on web 1/31/2006.

[31] 40 CFR Parts 150-189.

[32] STATE WATER RES. CONTROL BD., 2010 INTEGRATED REPORT CLEAN WATER ACT SECTIONS 303(D) AND 305(B) (Apr. 19, 2010), *available at* http://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2010.shtml

[33] http://water.epa.gov/scitech/swguidance/standards/criteria/alife/cem.cfm

[34] An MS4 is a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): (i) owned or operated by a public body; (ii) designed or used for collecting or conveying stormwater; (iii) which is not a combined sewer; and (iv) which is not part of a Publicly Owned Treatment Works (POTW). 40 C.F.R. § 122.26(b)(8) (June 12, 2006).

[35] http://cfpub.epa.gov/npdes/stormwater/rulemaking.cfm.

[36] http://gis.waterborne-env.com/downloads/CALFED_Final_Report_2011-Nov_2_FINAL.pdf

[37] CALIFORNIA DEPARTMENT OF PESTICIDE REGULATION. April 27, 2011 Comment Letter to EPA on The Advanced Notice of Proposed Rulemaking for Water Quality Challenges in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. *Available at* http://www.epa.gov/region9/water/watershed/sfbay-delta/pdf/comments/EPA-R09-OW-2010-0976-0033-1.pdf

[38] CALIFORNIA DEPARTMENT OF PESTICIDE REGULATION. February 2010 Draft Restrictions to address pesticide drift and runoff to protect surface water. *Available at* *http://www.cdpr.ca.gov/docs/emon/surfwtr/regs/drft_rstrctn_feb_2010.pdf*

[39] CALIFORNIA DEPARTMENT OF PESTICIDE REGULATION. October 28, 2011. Prevention of Surface Water Contamination. *Available at http://www.cdpr.ca.gov/docs/legbills/rulepkgs/11-004/11-004.htm*

[40] Brant Coberly Jorgenson (2011) Off-Target Transport of Pyrethroid Insecticides in the Urban Environment: An Investigation of Factors Contributing to Washoff and Available Mitigation Opportunities. University of California at Davis, Dissertation for Doctor of Philosophy in Agricultural and Environmental Chemistry.

[41] STATE WATER RESOURCES CONTROL BOARD. November 9, 2011 transmission of project funding derived from Grants Reporting and Tracking System.

[42] CALIFORNIA CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD. December 2008 Long-term Irrigated Lands Regulatory Program Background. *Available at http://www.swrcb.ca.gov/centralvalley/water_issues/irrigated_lands/long_term_program_development/dec2008_wkgrp_mtgs/long_term_program_background.pdf.*

[43] Other actions that significantly contributed to diazinon reduction in the Sacramento and Feather Rivers include urban product cancellation and label changes under FIFRA, CA DPR dormant spray regulations, BMP and IPM implementation, outreach, education, and research funded through various programs including the CWA Non-Point Source Grant Program.

[44] US EPA (2012) Improving California Central Valley Watersheds: Diazinon Reduction in the Feather and Sacramento Rivers. *Available at http://www.epa.gov/region9/water/watershed/measurew/feather-sac/2010SacFeatherRiverSP12final-Rpt.pdf*

[45] CALIFORNIA CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD. July 2010 Staff Report: A compilation of Selected Water Bodies and Aquatic Life Indicators for the Central Valley Pesticides Basin Plan Amendment. *Available at http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/central_valley_pesticides/aquatic_life/index.shtml*

[46] CALIFORNIA CENTRAL VALLEY REGIONAL WATER QUALITY CONTROL BOARD. February 2009 Final Staff Report: Relative Risk Evaluation for Pesticides Used in the Central Valley Pesticides Basin Plan Amendment Project Area. *Available at http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/central_valley_pesticides/risk_evaluation/index.shtml*

[47]Information on draft criteria reports is *available at http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/central_valley_pesticides/criteria_method/index.shtml*

[48] Minghua Zhang & Rachael Goodhue. Agricultural Pesticide Best Management Practices Final Report to CVRWQCB (March 2010). *Available at http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/central_valley_pesticides/ag_practices/index.shtml*

[49] Pers Comm. July 13, 2011. Daniel McClure, Environmental Engineer, Central Valley Regional Water Quality Control Board, Engineer in TMDLs/Basin Planning/NPS Delta Section.

[50] A Small MS4 is an MS4 that is not permitted under the municipal Phase I regulations, and which is "owned or operated by the United States, a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of sewage, industrial wastes, storm water, or other wastes, including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity…."(40 CFR §122.26(b)(16)).

[51] STATE WATER RES. CONTROL BD WATER QUALITY ORDER NO. XXXX-XXXX-DWQ NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) GENERAL PERMIT NO. CASXXXXXX WASTE DISCHARGE REQUIREMENTS (WDRs) FOR STORM WATER DISCHARGES FROM SMALL MUNICIPAL SEPARATE STORM SEWER SYSTEMS (MS4s) (GENERAL PERMIT). *Available at http://www.waterboards.ca.gov/water_issues/programs/stormwater/docs/phsii2012/draft_order.pdf*

[52] SAN FRANCISCO REG. WATER. QUALITY CONTROL BOARD (2009) San Francisco Bay Region Municipal MS4 NPDES Permit Order Number R2-2009-0074 *available at* http://www.swrcb.ca.gov/rwqcb2/board_decisions/adopted_orders/2009/R2-2009-0074.pdf; CENTRAL VALLEY REG. WATER. QUALITY CONTROL BOARD (2010) East Contra Costa Regional NPDES Municipal Permit Order Number R5-2010-0102 *available at* http://www.swrcb.ca.gov/rwqcb5/board_decisions/adopted_orders/contra_costa/r5-2010-0102_npdes.pdf

[53] see section C.3 "New Development and Redevelopment" in both permits (p. 16 and 21 respectively)

[54] http://www.epa.gov/region9/water/lid/#ms4

[55] see Section C.9 "Pesticides and Toxicity (p. 80 and 83 respectively)
[56] USEPA comments on Draft Phase II Small MS4 General Permit. Sent to Jeannie Townsend, clerk to the State Water Resources Control Board, September 8, 2011.
[57] The Regional Monitoring Program for San Francisco Bay
San Francisco Estuary Institute: http://sfei.org/rmp/.

[58] The Pulse of the Delta – Re-thinking Water Quality Monitoring (2011)
San Francisco Estuary Institute - Aquatic Science Center: http://www.sfei.org/node/3774

[59] USEPA's letter to Central Valley Regional Water Quality Control Board
Tentative Order/Draft NPDES Permit for Sacramento Regional County Sanitation District, Sacramento Regional Wastewater Treatment Plant (7 October 2010).

[60] Southern California Coastal Water Research Project (SCCWRP):
http://www.sccwrp.org/ResearchAreas/Contaminants/ContaminantsOfEmergingConcern.aspx.

[61] SETAC's Pharmaceutical Advisory Group and Nanotechnology Advisory Group; the workshop report *Managing Contaminants of Emerging Concern in California*; studies being done by the San Francisco Estuary Institute and the Southern California Coastal Water Research Program; a report to the SWRCB entitled *Monitoring Strategies for Chemicals of Emerging Concern (CECs) in Recycled Water*; and articles regarding the exposure of Delta fish to endocrine disrupters (Brander and Cherr 2008, Connon et al 2010, Riordan and Adam 2008, Sommer 2008); .

[62] SFEI's CECs Synthesis and their Emerging Contaminants Workgroup: http://www.sfei.org/projects/3678
http://www.sfei.org/rmp/ecwg

[63]International Joint Commission for the Great Lakes: *The Challenge of Substances of Emerging Concern in the Great Lakes Basin* (2009):
http://sustainableproduction.org/downloads/GreatLakesReportExecutiveSummary_001.pdf
http://www.ijc.org/en/home/main_accueil.htm

[64] http://water.epa.gov/scitech/methods/cwa/ppcp/index.cfm
[65] http://www.dtsc.ca.gov/PollutionPrevention/GreenChemistryInitiative/index.cfm
http://coeh.berkeley.edu/docs/news/2009-bcgc-acs.pdf
[66]Enhancing EPA's Chemical Management Program
http://www.epa.gov/oppt/existingchemicals/pubs/enhanchems.html

[67] Kimmerer, W. J., J.R. Burau, and W.A. Bennett. 2002. Persistence of Tidally-Oriented Vertical Migration by Zooplankton in a Temperate Estuary. *Estuaries*. Vol. 25, No. 3 (Jun., 2002), pp. 359-371. The ANPR included a substantial discussion of the science of estuarine habitat in the Delta. Since the release of the ANPR, there have been a number of additional contributions to the scientific understanding of estuarine habitat. These include Thompson J.R. 2010. Bayesian change point analysis of abundance trends for pelagic fishes in the upper San Francisco Estuary. Ecological Applications, 20(5), pp. 1431–1448.; Mac Nally, R., J.R. Thomson , W.J. Kimmerer, F. Feyrer, K.B. Newman, A. Sih, W. A. Bennett, L. Brown, E.F. Fleishman, S.D. Culberson, and G. Castillo. 2010. Analysis of pelagic species decline in the upper San Francisco Estuary using multivariate autoregressive modeling (MAR). Ecological Applications, 20(5), pp. 1417–1430; and Maunder, M.N. and Deriso, R.B. 2011. A state–space multistage life cycle model to evaluate population impacts in the presence of density dependence: illustrated with application to delta smelt (Hyposmesus transpacificus). Can. J. Fish. Aquat. Sci. 68: 1285–1306.
[68] Jassby, A.D., W.J. Kimmerer, S.G. Monismith, C. Armor, J.E. Cloern,T.M. Powell, J.R. Schubel, and T.J. Vendlinski. 1995. Isohaline position as a habitat indicator for estuarine populations. Ecological Applications 5: 272–289. Kimmerer and Monismith developed the X2 model to predict the location of X2 based on the preceding location of the isohaline and the present value of delta outflow, while Denton (Contra Costa County Water District) developed the G model to predict salinity at a particular location (intakes for drinking water) based on previous salinity conditions at that location and present delta outflow. Today, X2 positions are interpolated from measurements of salinity at four locations in the Bay Delta and reported daily. See the longer discussion of the X2

standard in the ANPR at pp 52..

[69] Thompson J.R. 2010. Bayesian change point analysis of abundance trends for pelagic fishes in the upper San Francisco Estuary. Ecological Applications, 20(5), pp. 1431–1448; Mac Nally, R., J.R. Thomson , W.J. Kimmerer, F. Feyrer, K.B. Newman, A. Sih, W. A. Bennett, L. Brown, E.F. Fleishman, S.D. Culberson, and G. Castillo. 2010. Analysis of pelagic species decline in the upper San Francisco Estuary using multivariate autoregressive modeling (MAR). Ecological Applications, 20(5), pp. 1417–1430.

[70] Maunder, M.N. and R.B. Deriso. 2011. A state–space multistage life cycle model to evaluate population impacts in the presence of density dependence: illustrated with application to delta smelt (*Hyposmesus transpacificus*). Can J Fish. Aquat. Sci. 68:1285-1306.

[71] This work by Michael McWilliams, a private consultant, using the UnTRIM hydrodynamic model was developed in the course of his work on the Sacramento Deep Water Ship Channel for the USACOE and in collaboration with Wim Kimmerer of SFSU.

[72] Feyrer, F., K. Newman, M. Nobriga, and T. Sommer. 2011. Modeling the Effects of Future Outflow on the Abiotic Habitat of an Imperiled Estuarine Fish. Estuaries and Coasts. 34:120–128 DOI 10.1007/s12237-010-9343-9.

[73] Feyrer, F., K. Newman, M. Nobriga, and T. Sommer. 2011. Modeling the Effects of Future Outflow on the Abiotic Habitat of an Imperiled Estuarine Fish. Estuaries and Coasts. 34:120–128 DOI 10.1007/s12237-010-9343-9.

[74]Feyrer, F., K. Newman, M. Nobriga, and T. Sommer. 2011. Modeling the Effects of Future Outflow on the Abiotic Habitat of an Imperiled Estuarine Fish. Estuaries and Coasts. 34:120–128 DOI 10.1007/s12237-010-9343-9; Feyrer, F., M. Nobriga, and T. Sommer. 2007. Multi-decadal trends for three declining fish species: Habitat patterns and mechanisms in the San Francisco Estuary, California, USA. Canadian Journal of Fisheries and Aquatic Sciences 64: 723–734; Dege and Brown 2004 [NEEDS CITE]

[75] Baxter et al. 2010; Winder, Monika, Alan D. Jassby and Ralph MacNally. 2011. Synergies between climate anomalies and these hydrological modifications facilitate estuarine biotic invasions. Ecological Letters. published online: http://onlinelibrary.wiley.com/doi/10.1111/j.1461-0248.2011.01635.x/full

[76] Santos, M. J., L. W. Anderson, and S. L. Ustin. 2011. Effects of invasive species on plant communities: An example using submersed aquatic plants at the regional scale. Biological Invasions 13: 30 443-457; Hestir, E.L., D.H. Schoellhamer, J.A. Greenberg, T. Morgan-King, and S.L. Ustin. In review. Turbidity Declines and Submerged Aquatic Vegetation Expansion in a Tidal River Delta. In review in Estuaries and Coasts.) The concept of a "regime shift" in the Estuary emerged recently in the scientific community, and refers generally to a shift from one ecological system to a different ecological system.

[77] Brander, S. M., I. Werner, J. W. White, and L. A. Deanovic. 2009. Toxicity of a dissolved pyrethroid 21 mixture to *Hyalella azteca* at environmentally relevant concentrations. Environmental Toxicology 22 and Chemistry 28: 1493–1499).

[78] Connon, Richard E., Linda A. Deanovic, Erika B. Fritsch, Leandro S. D'Abronzo and Inge Werner. 2011. Sublethal responses to ammonia exposure in the endangered Delta smelt; *Hypomesus transpacificus* (fam. Osmeridae). Aquatic Toxicology 105: 369-377.

[79] Parker, A.E., F.P. Wilkerson, R.C. Dugdale. In review, Elevated ammonium concentrations from wastewater discharge depress primary productivity in the Sacramento River and the northern San Francisco Estuary. Marine Pollution Bulletin).

[80] Glibert 2010

[81] Cloern, J.E., A.D. Jassby, J. Carstensen, W.A. Bennett, W. Kimmerer, R. Mac Nally, D.H. Schoellhamer and M. Winder. 2011. Perils of correlating CUSUM-transformed variables to infer ecological relationships (Breton et al. 2006, Glibert 2010). Limnology and Oceanography, in press).

[82] The history and background of the X2 standard is discussed at length in the ANPR at pp. 52-56 and the associated footnotes.

[83] Baxter et al. 2010

[84] Staff Report, Periodic Review of the 2006 Water Quality Control Plan for the San Francisco Bay/Sacramento-Estuary, at p. 19. Anticipated schedule presented by staff at SWRCB meeting, February 21, 2012.

[85] May 14, 2008 Final Staff Draft Delta Plan, page 146. *Available at:* http://deltacouncil.ca.gov/delta-plan/current-draft-of-delta-plan

[86] http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/index.shtml
[87] California Department of Fish and Game 2010. Quantifiable Biological Objectives and Flow Criteria for Aquatic and Terrestrial Species of Concern Dependent on the Delta.

[88] Luoma, Samuel, R. Fujii, B. Herbold, M. Johnson, W. Kimmerer, A. Mueller-Solger, P. Smith, D. Austin. 2011. Framework for a Unified Monitoring, Assessment, and Reporting Program (UMARP) for the Bay-Delta. Report to the Delta Council Science program February 2011, 66 pp.

[89] See longer discussion in ANPR at page 57.
[90] Fleenor 2010 [NEEDS A FULL CITE]. See discussion in ANPR.
[91] In fact, the draft report suggests that if streamflows are not sufficient "adult fish may delay their migration until a suitable year." Given the triennial life cycle and the fact that the absence of a functional migration corridor occurred in every fall between 2000 and 2010, the [draft report's] strategy for deferred migration is unlikely to yield positive results. I WOULD LIKE A SPECIFIC CITE FOR THIS; I COULDN'T FIND IT. POSSIBLY MOVE INTO TEXT.
[92] http://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/index.shtml at page??
[93] http://www.epa.gov/region09/water/tmdl/california.html

[94] See discussion in ANPR at page 59.

[95] See ANPR footnote….
[96] *Available at:* http://deltacouncil.ca.gov/science-program-event-products

[97]http://deltacouncil.ca.gov/sites/default/files/documents/files/Delta_Ecosystem_White_Paper_2011_10_18.pdf (page 4-5)
[98] http://www.bay.org/publications/from-the-sierra-to-the-sea-the-ecological-history-of-the-san-francisco-bay-delta-waters (page 2-30)
[99] http://deltacouncil.ca.gov/sites/default/files/documents/files/Delta_Ecosystem_White_Paper_2011_10_18.pdf
[100] CA DWR: *Subsidence in the Sacramento-San Joaquin Delta*http://www.water.ca.gov/floodmgmt/dsmo/bdlb/opp/subsidence.cfm
When most of the existing levees were constructed, the difference between the water level in the channel and the island surfaces was less than 5 feet. Because of the decreasing island-surface elevations, the levees are now required to hold back substantially more water than when they were originally constructed. The resulted increase in hydraulic pressures on levees that were constructed on foundations of sand, peat and organic sediments has caused about 35 levee failures since the 1930's. The primary reasons for levee failure are levee instability, seepage, and overtopping.

[101] *Sacramento-San Joaquin Delta Estuary TMDL for Methylmercury – Staff Report*; April 2010. http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/april_2010_hg_tmdl_hearing/apr2010_tmdl_staffrpt_final.pdf
Fate, Transport, and Ecological Effects of Mercury: http://www.epa.gov/mercury/eco.htm
[102] USBR-ESRI: The California Delta—Ecosystem Restoration Targets and Levees at Risk.
In comparing their maps of the early 1880s Delta with the early 2000s Delta (the latter not pictured here), Grossinger and Whipple found the maps revealed a reduction in historical tidal channel complexity with the damming of smaller waterways, channel widening, meander cuts, and straight connecting canals. The mapping done by USBR-ESRI led them to conclude that subsidence and anticipated sea level rise have limited restoration opportunities for aquatic and terrestrial habitats. This would apparently exclude the western Delta from consideration as a restoration target, however, USGS has demonstrated that subsided islands in the western Delta are restorable, and the subsidence reversible, through carbon farming with tule-based wetlands.
[103] http://water.epa.gov/lawsregs/guidance/cwa/dredgdis/
[104] http://www.waterboards.ca.gov/about_us/water_boards_structure/history_water_policy.shtml

[105] http://www.aswm.org/wetlands-law/swancc-decision; http://www.swrcb.ca.gov/water_issues/programs/cwa401/docs/wrapp/wetland_workplan2011.pdf

[106] http://water.epa.gov/lawsregs/guidance/wetlands/upload/2008_04_10_wetlands_wetlands_mitigation_final_rule_4_10_08.pdf

[107] http://ceres.ca.gov/wetlands/wetlands.pdf;
http://www.usda.gov/documents/NewsReleases/2005/04/conserve.pdf;
http://www.usda.gov/documents/08acc_cons.pdf;
http://scholarship.law.duke.edu/cgi/viewcontent.cgi?article=2025&context=faculty_scholarship;
http://www.vanderbiltlawreview.org/content/articles/2011/01/Ruhl-Salzman-Gaming-the-Past-64-Vand.-L.-Rev.-1-2011.pdf

[108] http://calwater.ca.gov/calfed/objectives/Ecosystem_Restoration.html
[109] http://online.sfsu.edu/~kimmerer/Files/KondolfEtAl2008EnvManagement.pdf
[110] Map of Delta Regions produced by Mount & Twiss (2005). Reprinted from *Envisioning Futures for the Sacramento-San Joaquin Delta* (page 49). http://www.ppic.org/content/pubs/report/R_207JLChapter3R.pdf

Map of the Restoration Opportunity Areas produced by BDCP.
http://baydeltaconservationplan.com/Libraries/EIR_EIS_Maps_and_Renderings/PO-Maps-Aug2010-2-Habitat-Restoration-Opportunity-Areas.sflb.ashx

[111] USGS has demonstrated that subsidence can be reduced at their Carbon Farm at Twitchell Island: http://ca.water.usgs.gov/Carbon_Farm/. Also, Dutch engineers studying land subsidence and flood risks in New Orleans have proposed flood control concepts that would redesign the city and include more waterways and wetlands as a hedge against tidal surges (http://dutchdialogues.com/about/). The concept of using aquatic features to reduce the risk of flooding seems ironic to some, but such a view is gaining acceptance among observers of the Bay Delta Estuary. The Dutch concept for redesigning New Orleans is consistent with, and would be bolstered by, proposals to restore wetlands within the waters of the Gulf Coast
(http://lacoast.gov/new/Default.aspx; http://www.americaswetland.com/).

[112]The Sacramento Corps District has already discouraged the construction of small residential, commercial, and institutional developments within the Delta by suspending nationwide permits #29 and #39.
http://www.spn.usace.army.mil/regulatory/nwp/NWP29.pdf ;
http://www.spn.usace.army.mil/regulatory/nwp/NWP39.pdf
The Final Compensatory Mitigation Rule can be found at:
http://www.epa.gov/owow_keep/wetlands/wetlandsmitigation/index.html

[113] http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/;
http://www.swrcb.ca.gov/sanfranciscobay/water_issues/programs/TMDLs/sfbaymercurytmdl.shtml

[114] Delta Dredged Sediment Long-Term Management Strategy (LTMS): http://www.deltaltms.com/

[115] Dutch Slough Restoration Project
http://www.dutchslough.org/homepage.html
http://www.fws.gov/cno/conservation/coastal.htm

[116] EPA's San Francisco Bay Area Water Quality Improvement Fund
http://epa.gov/region9/water/watershed/sfbaywqfund/index.html
http://www.dutchslough.org/DutchSlough_Maps.html

[117]http://www.dutchslough.org/Documents/AMWG%20Docs/Opportunities_and_Constraints_Final_Report.pdf

[118] USGS Carbon Capture Farming Program at Twitchell Island: http://ca.water.usgs.gov/Carbon_Farm/.

[119] *Greenhouse Gas Reduction and Environmental Benefits in the Sacramento-San Joaquin Delta: Advancing Carbon Capture Wetland Farms and Exploring Potential for Low Carbon Agriculture*.
http://www.stillwatersci.com/new_and_notable.php?id=216
[120]*Ecosystem services in decision making: time to deliver* in Frontiers in Ecology and the Environment (February 2009); Ecology Society of America; http://www.esajournals.org/doi/full/10.1890/080025
[121] *California's Yolo Bypass: Evidence that flood control can be compatible with fisheries, wetlands, wildlife, and*

agriculture. Fisheries (AUG 2001).
http://wfcb.ucdavis.edu/www/Faculty/Peter/petermoyle/publications/YoloFisheries.pdf
Liberty Island Provides Insights into Delta Ecosystem Restoration. Delta Stewardship Council (April 2010).
http://science.calwater.ca.gov/publications/sci_news_0410_liberty.html
Yolo Basin Foundation: http://www.yolobasin.org/wildlife.cfm
Sacramento Corps District; re-vegetation projects in the Yolo Bypass and Cache Slough.
http://www.spk.usace.army.mil/projects/civil/distreveg/

[122] http://www.yolobasin.org/wildlife.cfm

[123] Successful Fish Rescue Completed at Tisdale and Fremont Weir off Sacramento River:
http://cdfgnews.wordpress.com/tag/sturgeon/

[124] *Envisioning Futures for the Sacramento-San Joaquin Delta* (FEB 2007); pages 70, 75-76, 78-79
http://www.ppic.org/content/pubs/report/R_207JLChapter4R.pdf

[125] *Mercury, Methylmercury, and Other Constituents in Sediment and Water from Seasonal and Permanent Wetlands in the Cache Creek Settling Basin and Yolo Bypass, 2005–06*. USGS Open-File Report 2009-1182
http://pubs.usgs.gov/of/2009/1182/; http://ca.water.usgs.gov/mercury/cacheCreek.html

Methylmercury cycling, bioaccumulation, and export from agricultural and non-agricultural wetlands in the Yolo Bypass. 30 September 2010. San Jose State University Foundation.
http://swrcb2.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/delta_hg/other_technical_reports/ybwa_hg_final_rpt.pdf

Mercury Inventory in the Cache Creek Canyon – Bear Creek Confluence to Rumsey. Central Valley Regional Water Quality Control Board (March 2011)
http://www.swrcb.ca.gov/centralvalley/water_issues/tmdl/central_valley_projects/cache_sulphur_creek/cache_crk_rumsey_inventory.pdf

[126] Abott/Turkey Run Mine
http://naturalresources.house.gov/UploadedFiles/MeerTestimony11.23.09.pdf

Sulphur Bank Mercury Mine
http://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/ViewByEPAID/CAD980893275?OpenDocument
Amending the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins for the Control of Mercury in Clear Lake.
http://water.epa.gov/scitech/swguidance/standards/wqslibrary/upload/2009_03_16_standards_wqslibrary_ca_CA5-AMD-0002_092603.pdf

Existing forums include the Cache Creek Watershed Meetings and the Delta Tributaries Mercury Council:
http://www.srwp.org/issues/mercury/dtmc/

[127]NRCS'Bay Delta Landscape Initiative -
http://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/?ss=16&navtype=SubNavigation&cid=stelprdb1041880&navid=100100150000000&pnavid=100100000000000&position=Not%20Yet%20Determined.Html&ttype=detailfull&pname=Bay%20Delta%20Initiative%20%7C%20NRCS
http://www.nrcs.usda.gov/programs/wrp/states/ca.html

The designation of a *South Delta Bypass* was a central feature of a legal settlement surrounding the proposed development of the River Islands subdivision on Stewart Tract - http://www.nrdc.org/media/2008/080404.asp

San Joaquin River Restoration Program - http://www.restoresjr.net/
San Joaquin River Restoration Partnership - http://www.sanjoaquinriverpartnership.org/
San Joaquin River National Wildlife Refuge - http://www.fws.gov/refuges/profiles/index.cfm?id=81654

Tuolumne River Trust: Dos Rios Ranch acquisition & restoration - http://www.tuolumne.org/content/article.php?story=20081108122515845&query=Dos%2BRios%2BRanch

Central Valley Flood Management Planning (CVFMP) Program - http://www.water.ca.gov/cvfmp/